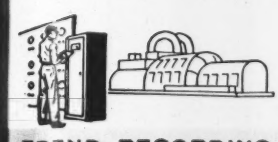
INSTRUMENTS and AUTOMATION



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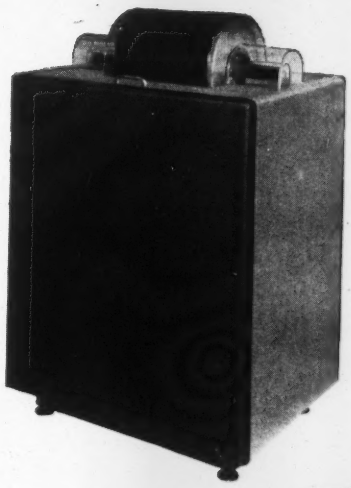

DATA PROCESSING with a Quasi-Random-Access Memory

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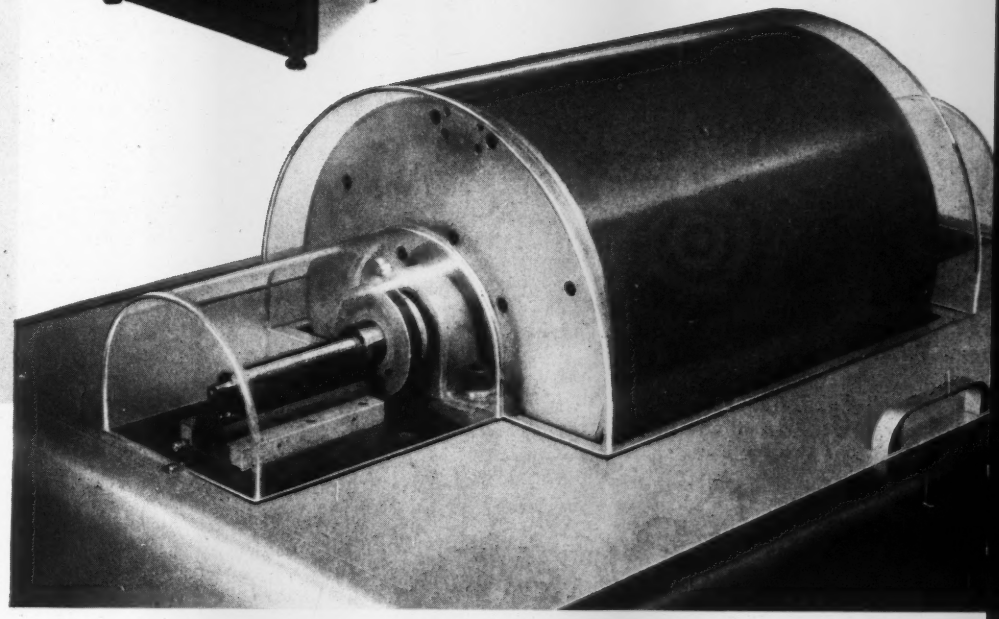

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VOL. 29 NO. 4 APRIL 1956

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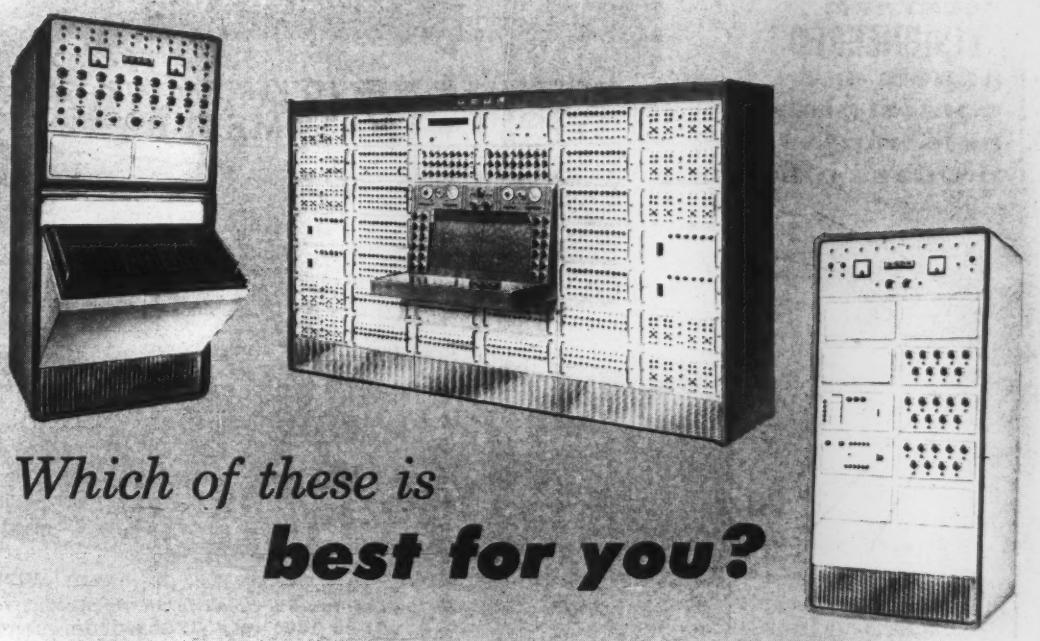

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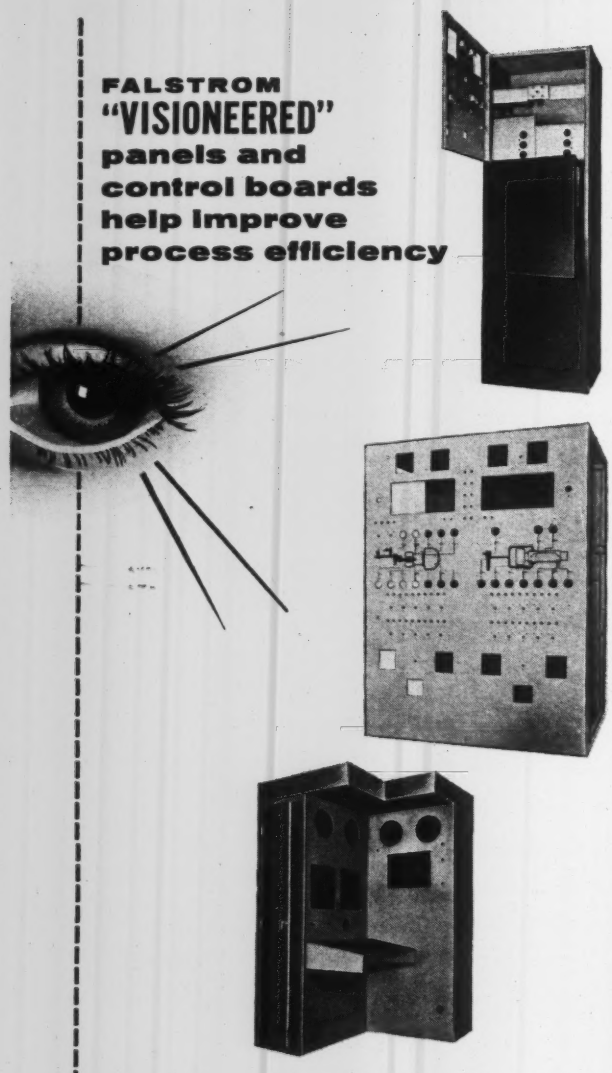

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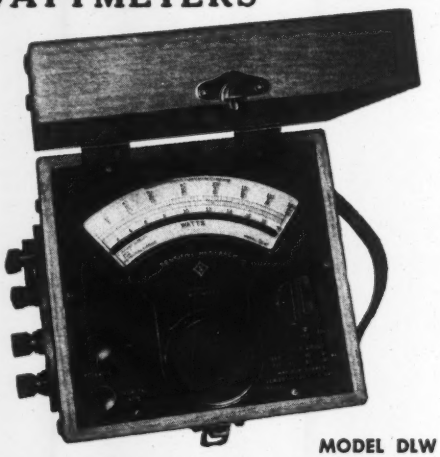

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INSTRUMENTS and AUTOMATION

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL FOR 28 YEARS – SINCE JANUARY 1928

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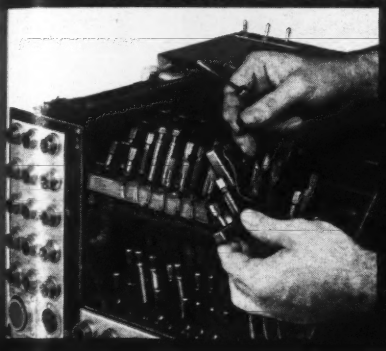

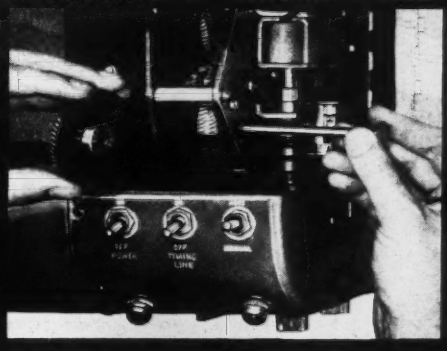

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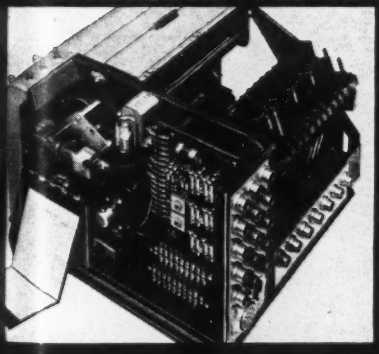

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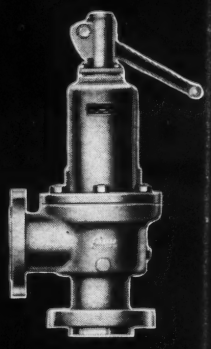
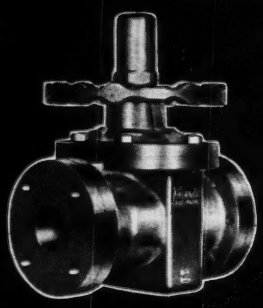


1945



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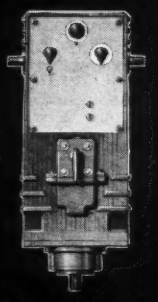

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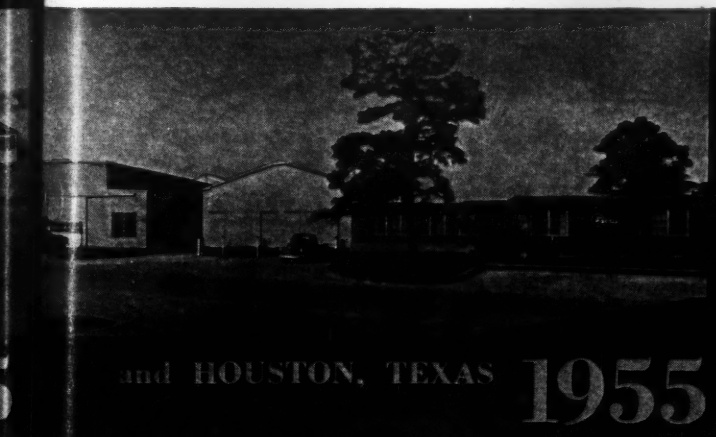

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INSTRUMENTS and AUTOMATION

Letters to the editor

Editor, I&A:

Your editorial "Automation, Revolution and Insight" (*March, I&A*) is excellent. It contains many of the points that I find myself repeatedly emphasizing to potential computer users.

On a recent visit to a large petroleum processor, I discussed a few additional aspects of the current situation. Those aspects which pertained to this subject were briefly as follows:

In the chemical and petroleum fields, relatively little emphasis is placed on study of process dynamics; either in schools or industrial laboratories. This situation is quite different in the electrical field where the student or engineer spends most of his time studying dynamic problems. Perhaps we can ascribe this discrepancy to the fact that the static aspect of chemical reactions is so complex and nonlinear that people just don't get around to considering dynamics. Today, we cannot afford the luxury of ignoring something just because it is complex. Tremendous savings in production costs can result from better dynamic control. The analog computer provides a means to greatly facilitate dynamic study of processes with the aim of realizing those savings.

As you so correctly point out, these studies achieve a two-fold objective: the specific numerical answers required, and, most important, a greater understanding or intuitive feel for the dynamics of the process. Numerical answers alone can often be meaningless or misleading if they are not accompanied by an increased understanding of the process.

Good luck with the good fight.

John D. Strong
Princeton Computation Center
Electronic Associates, Inc.
Princeton, N. J.

A good (and important) fight this is—and it is being waged at its most important point. The instrument engineer in the plant is the man in position to supply the dynamics data needed to make a general breakthrough on a wide front. We will keep applying pressure until this breakthrough is realized. The Simulation Council Newsletter and the Computer Clinics of the Automation Expositions are important weapons in this fight—all process men are urged to sign up early for the Third Computer Clinic, Third International Automation Exposition, New York, Nov. 26-30.— **See page 729.**

Editor, I&A:

Your editorial [Automation, Revolution and Insight, *I&A*, Feb., 1956] is very interesting but I cannot agree with your basic premise, namely, that analog computers are a revolutionary development when compared to servomechanisms and automatic controllers. I would like to call your attention to the fact that the first differential analyzer was constructed by Bush in 1929. Furthermore, the design and development of electronic analog computers are intimately related to corresponding advances in servomechanisms and feedback amplifiers.

However, I do believe in the importance and significance of analog computers: It is easier and more economical to simulate the dynamic performance of many physical situations on an analog computer than to build prototypes. (2) Once a problem is set up on an analog computer, it is a simple matter to investigate the effect of variations of parameters, i.e., modified configurations of the original systems. (3) "Insight" into a problem may occur as the engineer becomes familiar with the dynamic behavior of the system. It would be more appropriate to use the word understanding instead of insight. Since the computer generates many solutions in a short space of time, it increases the familiarity of the engineer with the system and to this extent provides an understanding of the problem. (4) Computer solutions are implicit in the statement of the problem and no new knowledge or intelligence is originated by the computer, either analog or digital. The usefulness of a computer arises from the speed with which it can solve a problem as compared with hand calculations.

Bernard Loveman
Reeves Instrument Corp.
New York 28, N.Y.

This is an interesting switch—the computer man telling the automatic control man that the computer is less revolutionary than the automatic controller. However, although the first differential analyzer was constructed in 1929, and although the first general-purpose simulator was introduced in 1947 or 1948—by Reeves—the use of the analog computer that is termed "revolutionary" in the editorial—the simulation of an operating plant from within the plant, based on operational characteristics—has still NOT BEEN DONE to any practical degree. When it will be done—which we hope is soon (particularly in view of our strenuous efforts in this direction for more than a year), we submit that truly revolutionary results will be forthcoming.

Editor, I&A:

I am writing a book which I have tentatively given the title, *How Old is Old?* This has grown out of my interest in older people that began when I was a student nurse, about 25 years ago.

I would be most grateful if you would give me the names of older people among your readers and in your field who have made themselves a satisfying life in their later years.

It doesn't matter if the triumph is in a related field, a second career, or a hobby. Just so that it gives evidence that one who starts pushing past the '40s, '50s, and '60s can be happy because he has something to contribute and is useful; that being *older* isn't a social disease that only a few of the unwary catch; but that we're all in for it—good ancestry, good health and the good Lord willing; that we must start preparing for our later years—the sooner the better.

I should appreciate knowing about some of the triumphant older people in your field. I am sure that your readers include many wonderful older people—like some of the ones I already know.

(Miss) Vieno Johnson
327 W. 83 St., S-3S
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*T. M. REG.

For more information circle 8 on inquiry card.

LETTERS—CONTINUED

much of the labor is precise rather than hard, where imagination is needed more than strength, where the aged might contribute much. We urge those for whom Miss Johnson is looking to communicate with her—and we urge Miss Johnson and others to investigate the possibilities within our field for the "old."

Editor, I&A:

As subscribers and readers of *Instruments and Automation* we at Industrial Electronics, Inc. would like to congratulate you on your fine publication.

Being in the business of building electronic instruments for industry's automation processes, we certainly appreciate the timely articles that appear in *Instruments and Automation.* However, in addition to being a reader, how may one become a contributor to this publication? Our experiences in this field have been quite extensive and would make interesting, instructive reading material.

Clarence E. Hothem
Industrial Electronics, Inc.

This is an easy one—send your manuscripts or ideas to us for review at 845 Ridge Avenue, Pittsburgh 12, Pa.

Editor, I&A:

Some time ago we purchased 5000 reprints of the article, "Electronic Data-processing Machines," by G. T. Hunter and G. M. Clark, which appeared in *Instruments and Automation* of May 1955. We have had considerable demand for this article and wonder if we might purchase an additional quantity of 3500 copies.

Jacqueline M. Decker
International Business Machines Corp.
New York 22, N. Y.

We print this letter to show what happens to an important article in a technical publication. In addition to the many thousands distributed by IBM, requests for reprints in quantity were received at this office from petroleum plants, steel mills, banks, large retailing organizations, etc., showing how this type of basic education spreads far from the source. We urge readers who happened to miss this article and who wish to know the basic possibilities of electronic data processing machines to refer to

their May 1955 issue of *Instruments and Automation*. The article also appears along with five other important computer articles in the *Computer Handbook* (available at $2.00 from us).

Editor, I&A:

Your recent editorial "Automation and Culture" is worthy of much wider circulation than the highly select group of your usual readers.

It is a pity that the very concepts discussed by you require a modicum of cultural attainment sadly minimized by the educators of Technical America. It's a real "Operation Bootstrap" in which all men of goodwill should come to one another's aid.

Edward S. Naidus
Associate Scientist
United Shoe Machinery Corp.

Editor, I&A:

Our department finds it necessary to expand its staff beginning with the academic year 1956-1957. We will probably appoint two new people. The areas in which we are most interested now are production planning and control, automation and tool engineering, and data processing.

Washington University has a beautiful campus located on the outskirts of the City of St. Louis.

Could you suggest some names of possible candidates for one of our openings? Our positions would entail a rank of Assistant Professor or Associate Professor with salary commensurate with experience and education background.

Gerald Nadler
Dept. of Industrial Engineering
Washington University
St. Louis 5, Mo.

Who's for the campus life? Every "good" man has a secret desire to teach. Here are some good opportunities.

Editor, I&A:

Reference is made to the article "Valve Capacity and C_v" by Mr. G. S. Beard, in the February, 1956 issue of *I&A*.

I would like to clarify a few symbols that have always been a point of ambiguity:

(1) The C_v which is listed by manufacturers is invariably obtained from a test based on a straight run of pipe preceding the control valve. The C_v obtained under test conditions does not apply to 99.9% of the installations which have the control valves located in a "U" type loop and are preceded by block valves and swedges upstream and downstream of the control valve.

The "U" type of installation reduces the C_v of the valve, and for that reason an adjustment in the experimental C_v should be made before applying the control valve.

(2) "Q_L" is the flow of liquid in GPM at the *flowing temperature* and should be specified as such.

(3) "G", specific gravity for liquids, is based on the gravity at the *flowing temperature;* but for gases and vapors, "G" is based on the specific gravity at standard temperature and pressure conditions—i.e., 14.7 psia and 60°F.

Joseph Conison
Instrument Engineer
The Fluor Corporation, Ltd.
Los Angeles, Calif.

We hasten to remove these ambiguities from an article designed to eliminate other ambiguities in use of the C_v factor. The effect of valve piping on both valve capacity (C_v) and valve characteristic was brought out in the article "Valve Piping Effects" which preceded the article "Valve Capacity and C_v" in the same (February) issue of *I&A*.

Editor, I&A:

We are making a study for Electricite de France (The French Power Company) of the latest developments in the field of instrumentation, as far as large Modern Steam Power Stations are concerned (100 MW per unit and above).

We know that our best source of information is your excellent magazine "Instruments"—The writer is a subscriber since 1946 and enjoys reading it every month. Most of the issues, however, were sent to other members of our staff and never come back.

Could you, therefore, send us a list of the articles which have been published on the subject, over the past two years for example?

Let us congratulate you most sincerely for the quality of your magazine. It would be difficult, indeed, to do a better job in that field.

D. C. Lefebvre,
French Office of Power Stations
Washington 6, D. C.

The following five basic articles add up to a thorough analysis of modern steam power generation: (1) Art of Engineering a Power Station (R. E. Marion, June, 1954); (2) Fundamentals of Combustion Control Systems (A. Waxman, Oct., 1954); (3) Instrumentation of a Modern Steam Generating Facility (J. Katzenmeyer, June, 1955); (4) Automatic Steam Generation (H. Peth and J. Kotsch, Dec., 1955); (5) Instrumentation of a New Steam-Generating Facility (F. Hicks, Jan., 1956).

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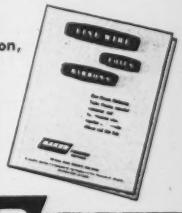

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Free wheeling ball bearing action. Roller type with flare cut-off groove. Retractable reamer. No. 274-F for ⅛" to 1" O.D. tubing. Other models for sizes up to 2¼" O.D. Also sawing vises for 3/16" to 4" tubing.

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INSTRUMENTS and AUTOMATION Inquiries

The inquiries below were received from subscribers to **Instruments and Automation**. In most instances an answer has been sent, but we shall be glad to forward the name and address of the inquirer if you have any further suggestions.

Flowmeter for Granular Material

Reader seeks propeller type flowmeter suitable for use on granular material. A-65

Vibration Recorder

Steel company wishes to rent portable vibration recorder. A-66

Moisture Meter

Flooring company seeks manufacturer of an instrument that can be used satisfactorily in testing the moisture content of concrete. A-67

Photoelectric Scanner

Research laboratory seeks "photoelectric scanners for mercurial barometers." A-68

Bevel Gear Assemblies

Assoc. Prof. of microbiology desires information on firm to contact for bevel gear assemblies with right-angle drive from a common shaft. A-69

Wind Counting Device

Forest Service of the U. S. Dept. of Agriculture is interested in finding firms who would manufacture a wind-counting device to be used in conjunction with contact-type anemometers, for totalizing velocity up to 90 mph.; eliminating battery drain if the anemometer stops on a contact-point; and eliminating spurious count due to chatter of contact points while making or breaking. A-70

Alcohol-in-Blood Indicator

British firm is interested in purchasing instruments described as follows: "Widmark Instruments with torsion weight 10-500 Mg. indicating alcohol in blood . . . Each instrument to be supplied with 2 additional glass Widmark vessels." A-71

Wirewound Resistors

Manufacturer of hearing aids seeks supplier of small wirewound resistors and small wirewound potentiometers, for a noise generator. A-72

Fire Shields

Fuel Company is interested in obtaining two or three dozen "fire shields" (protective shield approximately 8" wide by 12" long, about ¼" or ⅜" thick that has an inspection glass in it through which a furnace fire can be observed). A-73

Rubber Conductivity Meter

Rubber processing company seeks a conductivity meter for measuring the conductivity of rubber flooring in hospital rooms. Scale to read 0-2,000,000 ohms. Recommended maximum conductivity for rubber compounds of this nature is 500,000 ohms. A-74

Down-Time Recorder

Manufacturer of laxative pills seeks production recorder with telephone dial switch to record trouble when machine is down. A-75

Leak Detector

Processor of blood plazma, which is dried into powdered form in sealed glass bottles under a sustained vacuum of 24 to 25 inches, seeks sturdy vacuum leak detector (preferably spark jump type) for production testing. A-76

Clock with Contacts

Staff engineer in company manufacturing aircraft flight analyzers seeks spring-driven clockwork with electric contact to switch remote communication equipment. Duty 1 to 2 weeks, continuous. A-77

pH Electrode for Slurry

Foreman in mining company seeks a dependable pH control electrode for solutions containing undissolved abrasive sand such as found in zinc leaching process. A-78

Ultrasonic Drills

Underwriters' Laboratories is interested in obtaining information on ultrasonic drills and names of manufacturers. A-79

Enthalpy Computer

Engineer in public utility company seeks Enthalpy Computer. A-80

D-C Circuit Breaker

Test engineer with railway company seeks a small d-c circuit breaker having instantaneous response to increases in applied voltage. Device should be adjustable for normal closed circuit operation on voltages ranging from 6 to 30 volts direct current, maximum 6 amperes. It should function on voltage increases to a value 50 percent higher than the set voltage by instantly opening the circuit. For instance, if the device were controlling a circuit operating at 12 volts it should open the circuit if the voltage increased to 18 volts or higher. A-81

The Model TC-2 Temperature Test Chamber is a portable, self-contained, easy-to-operate unit ideal for laboratory and production line use.
Write for literature.
Temperature Range: −65°F to +350°F.
Holding Accuracy: ±2°F.
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MODEL TC-2
PRICE, $550.00
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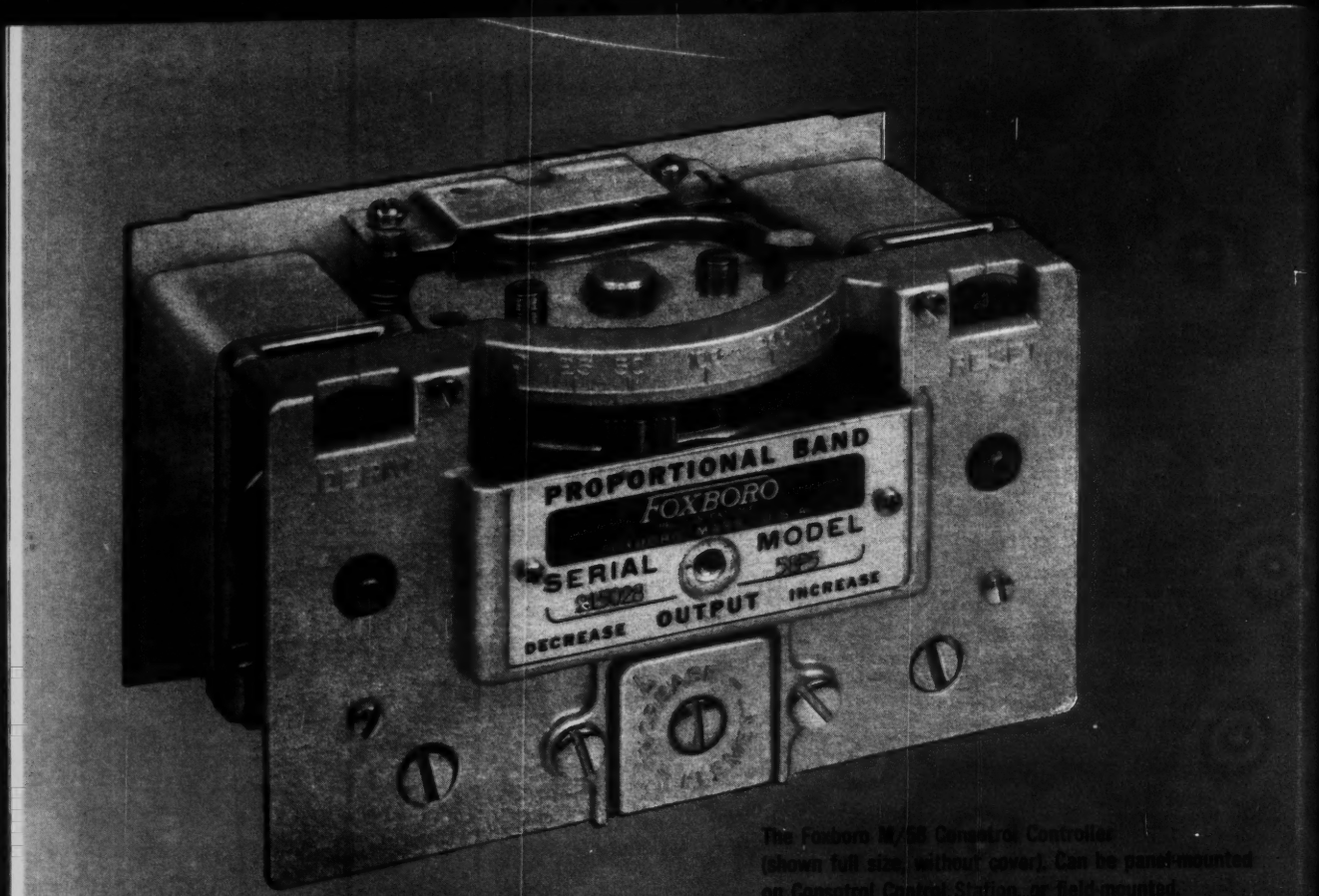


The Foxboro M/58 Consotrol Controller (shown full size, without cover). Can be panel-mounted on Consotrol Control Station, or field-mounted.

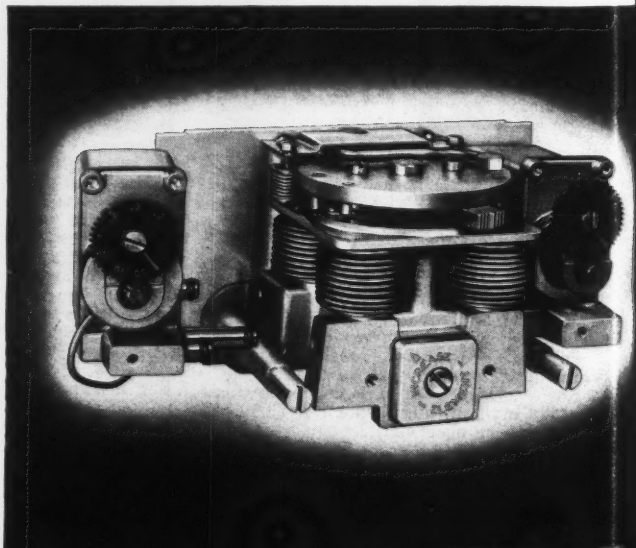
THE FOXBORO M/58 CONSOTROL

The M/58 Controller's Revolutionary Floating Disc System

Here's the exclusive Foxboro design development that gives M/58 Control its unique versatility, precision, and stability. The floating disc and matched bellows assure uniformly high controller sensitivity and pin-point control action, even at widest settings of the proportional band. Lever-set proportional band adjustment is calibrated to 500%.

Component Construction Gives Unrivaled Versatility

Not only is the complete controller easily detachable as a unit, but also, each component is a "plug-in" unit. For example, reset plugs in at right as shown; derivative, similarly, at left. All 4 control actions, with 2 reset ranges, are available and easily adjustable to widest variations in operating conditions. Proportional action from 1 to 500% quickly set by lever.



Outperforms all other controllers!

...the controller with the FLOATING DISC

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller on your process. The tougher the job, the more it will outperform other controllers! Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this exclusive Foxoboro development has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

The M/58 Controller can do the same for your process. The flexibility of its control functions makes it readily adaptable to *all* processing techniques. All four actions are available, with two ranges of reset . . . all are easily adjustable to the most widely varying operating conditions. For example, reset and derivative functions plug in . . . proportional action from 1 to 500% can be quickly set by a lever. And calibration is a simple zero adjustment!

Get full details on this simple, truly "universal" Controller. Write for Bulletin 13-19 and ask your Foxboro Sales Engineer for a demonstration. **The Foxboro Company, 464 Neponset Ave., Foxboro, Mass., U.S.A.**

*Reg. U.S. Pat. Off.

FOXBORO **CONSOTROL INSTRUMENTS**

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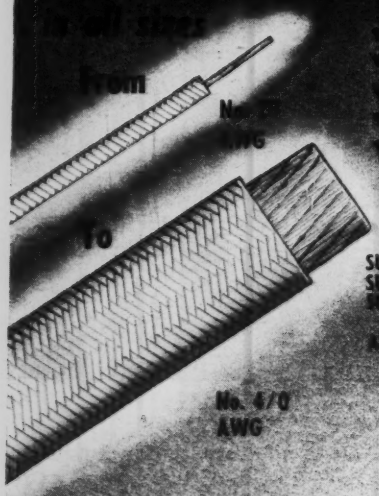

- HIGH TEMPERATURE RESISTANCE OF NICKEL CLAD COPPER CONDUCTORS,
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... to give the aircraft industry an electrical cable that will withstand continued ambient temperatures over 600 F and still maintain . . .

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MANUFACTURED WITH THE SAME HIGH QUALITY MATERIALS AS OUR HIGH TEMPERATURE CABLE

Available in all classes and types, specify LEWIS thermocouple wire for dependable thermocouple, thermometer installations

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THE LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

INSTRUMENTS and AUTOMATION Trends

Government plans to launch up to 10 basket-ball sized satellites into space by 1958. Research is underway on telemetering gear. Exciting possibilities are ahead--output of photocells and solar cells will be much greater owing to lack of intervening atmosphere—and some metals and semiconductors become superconductors at the near-absolute zero of outer space. New fields of electronics and instrumentation may be in the making.

New York is first state to adopt a comprehensive safety code for protection of workers against radioactivity in conformity with recent AEC regulations with Industrial Code Rule 38.

Late table of transistors (by Rufus Turner in Radio-Electronics, Feb. 1956) shows 116 types of general-purpose transistors from 16 manufacturers. Point-contact type has almost disappeared. Most are p-n-p junction type. Four silicon types listed have the max temperature rating (150°C). Texas Instruments is only source listed for silicon transistors.

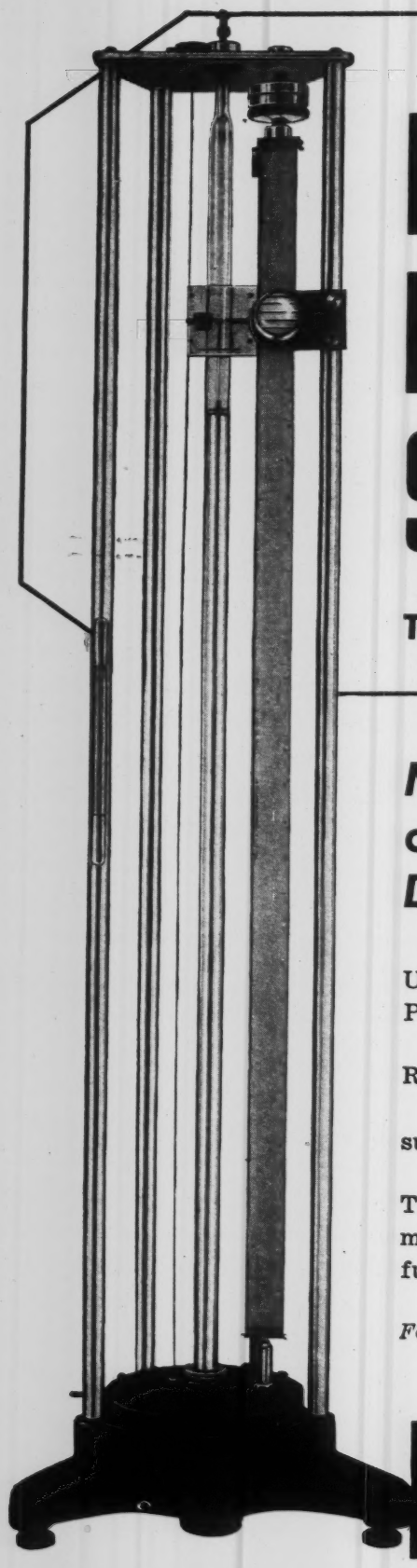
Estimates of nuclear power capacity by 1970 vary from 5 to 200 million kw installed capacity.

Potential of the machining and metal-forming industries for automation equipments has been subject of study by ASTE. They report: Medium-size plants with 250-1,000 employees (not really big ones) are most adaptable to automation. Automation eventually can be applied to about 16% of all metalworking operations—this will require replacement of 200,000 machine tools, 55,000 grinders and finishers, 50,000 metal-forming machines, 25,000 production welders—plus loading devices, control equipment, etc.

ASTE reports that machining is 25% automatable; metal forming 25%; production welding 15%; grinding and finishing 15%; materials handling 23%; inspection 17%.
ASTE reports that single biggest factor that would accelerate automation would be development of standardized units that could be used even when models were changed.

First comprehensive study of helicopter navigation requirements has been made by Stanford Research Institute for Bendix Aviation Corporation. Copies are available to qualified persons from Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood, Calif.

Helicopter air carrier industry will not grow beyond experimental proportions until the advent of multi-engine aircraft in production quantities—about 1960—says SRI report for Bendix. Predicted helicopter air traffic potential is approximately 560 multi-engine aircraft between 1955 and 1965. Commercial market for a major airborne helicopter navaid will be approximately 1200 units by 1965—mostly military. Stability problem in helicopter hovering flight is serious. Autopilot developments are now in process at Bell, Kaman, Sperry, Minneapolis-Honeywell, Ryan, and Saunders Associates.



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Measures *Absolute* or *Differential Pressure*

Used interchangeably as a Barometer or Differential Pressure Manometer.

Range: 0 to 800 mm of Hg.
0 to 31.5 in Hg. or in any other desired pressure unit of equivalent range.

The magnetic vernier reads to 0.01 mm or 0.005 in. of mercury with an accuracy of 1 part in 5000 over the full range.

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Speed plus sensitivity—15 microvolts d-c per millimeter—1/120th second deflection time.

Completely stable—has absolute zero base line drift.

No hysteresis—high-torque—returns stylus to base line—even with paper stationary.

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OFFNER DYNOGRAPH RECORDERS

Offner Dynograph Recorders are the result of 20 years of development and production experience. Originally used in the electro-medical field where high speed and sensitivity to minute signals were imperative, industrial models of the Dynograph *have established many new performance standards for direct-writing oscillograph recorders.*

Compare the Offner Dynograph with all other direct-writing oscillographs on the market today—if you do, you'll choose the Dynograph.

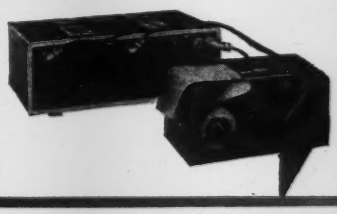
High sensitivity—up to 15 microvolts per mm.
Stability—absolutely drift-free
No "warmup"—immediately stable and ready to use
One percent linearity—for 5 centimeters deflection
One amplifier—for all recording applications
Large, easy to read and easy to measure records
Rapid pen response—1/120th second deflection time

If you want the widest versatility, highest accuracy, and greatest reliability in direct writing high speed oscillographs—select the Offner Dynograph! It's the result of 20 years of development and production experience.

Write for your copy of the Dynograph Bulletin; get complete details and application information. Our Engineering Representative in your area will demonstrate the Dynograph in your plant—write for a demonstration date.

Type MC Console. *Specially designed for computor write out, telemetering, and other low gain applications.*

Type M Console. *Accommodates up to six recording channels with specialized input couplers, for a wide variety of applications—eight chart speeds, 1 to 250 mm. per second.*



Type P Portable Dynograph. *Single and Dual Channel Units—performance specifications identical to those of the console model—Chart speeds from 1 to 100 mm. per second.*

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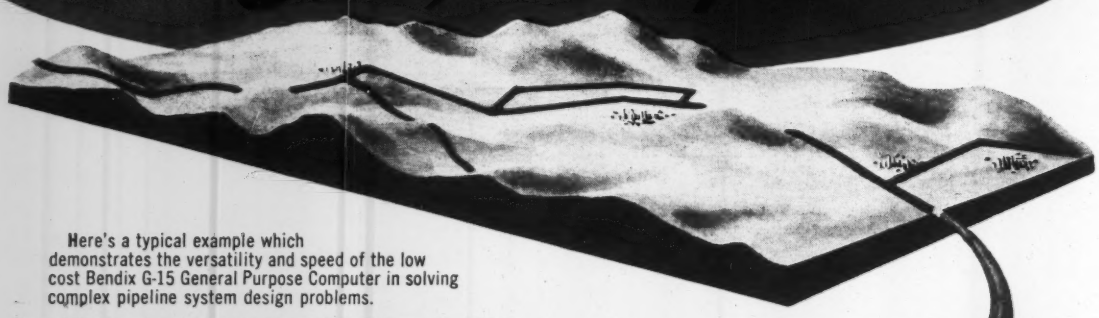
GIVES THE ANSWER TO PIPELINE DIFFERENTIAL PRESSURES... IN SECONDS!

Bendix Computer



Here's a typical example which demonstrates the versatility and speed of the low cost Bendix G-15 General Purpose Computer in solving complex pipeline system design problems.

A proposed system of pipelines 160 miles long with 1800 feet variation in altitude, was to consist of a number of pipes of different diameters running in parallel over eleven given sections. At the end of the sections, gas was to enter the flow from another source or be branched off to another destination. In addition, two compressors were to be placed at various sections along the line.

6 SECONDS TO SOLVE EACH STATION

After the problem has been entered into the Computer only 6 seconds per section are required to solve and print the answer for each station, giving pipeline pressure, flow rate of the gas and the mile posts.

In addition, the Computer requires only 8 seconds to provide the following for each compressor calculation: fuel used, brake H.P., sea level H.P., compression ratio, suction pressure and discharge pressure.

The Bendix G-15 is an entirely new concept in electronic computation. Its unusually low cost, large capacity and speed make it an economically sound investment for research, engineering and control functions, even for so-called "small' company operations.

Let us send you complete information on how the Bendix Computer can effectively serve you.

Bendix Computer

Bendix Computer Division, Bendix Aviation Corp.
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Tell us how we can economically use the Bendix Computer in our engineering, research and control functions.

Name _____ Title _____

Company _____ Address _____

For more information circle **16** on inquiry card.

Panhandle Pete

What's The Other Wire For?

As a former worker on this sort of thing and having suffered many years with other people's mistakes, I believe it is time to mention a few of them so that the art may be improved.

In the first place there is the electrical department—solid as a rock, spread out in all directions like an octupus and yet as elusive as an Ohio Valley fog. When you call upon the chief electrician to discuss your controls you find out that he is too busy so he sends you out in charge of "the girl" who leads you way down the hall past the janitor's room, around the corner past the door marked "Gentlemen" to a hole in the wall—the office of the twenty-third assistant engineer whose name is T. Edison Steinmetz, Jr. This expert, who hasn't begun to shave yet, not only doesn't know anything about what your controls are controlling but he doesn't understand the symbols on your plans, so there is a translation of ideas from yours to his whereby many things are lost as in all translations.

After many days of waiting and phoning, *The Plans* are unveiled and it is your turn to look with awe upon the six-by-ten foot blueprint of strange symbols and lines which have grown, like a toadstool, from your odds and ends of plans. Especially you gawk at a big empty space down in the right-hand corner of the thing where you are supposed to affix your John Henry that all is well!

The second surprise comes when you look at what the wire gang has built from the plans given them. These boys are used to handling power—lots of it—so your little clock motors, 110-va controls, ten-watt amplifiers, and flea-power drives are all protected by sixty ampere fuses. And did you want a switch or two? Why certainly; you'll find out that a hundred-amp switch is just what the wire gang Boss thought you wanted. The wire gang likes to make a neat job of these panels so they will wire it up with mouse-gray colored wire which looks good but is hell to track down in case of trouble. When it comes to running, say, six wires out to a drive unit, these boys will supply a ten-conductor cable as big around as your arm, just to be safe. Of course none of the conductors are smaller than number eight wire, which means that when it comes to connecting these big wires to the dainty little terminal boards furnished by the instrument people, something has to give. Some choice vocabularies have been built this way.

The third surprise comes usually at 5:00 a.m. when the phone rings at your home and a gruff voice on the other end says that "Number so-and-so furnace has been down for six hours and that blankety blank strap-hanger you have here on turns can't . . . so get your *** over here and fix this———!" Upon arrival at the scene of trouble you'll find your turn man behind the panel board surrounded by what looks to be a bushel of fuses. To get out of trouble and postpone the Manager's death by high blood pressure you by-pass the control with extension cords and plugs which lets you run the control until 'The next turn come out.' The electricians are always able in some mysterious way to locate these troubles.

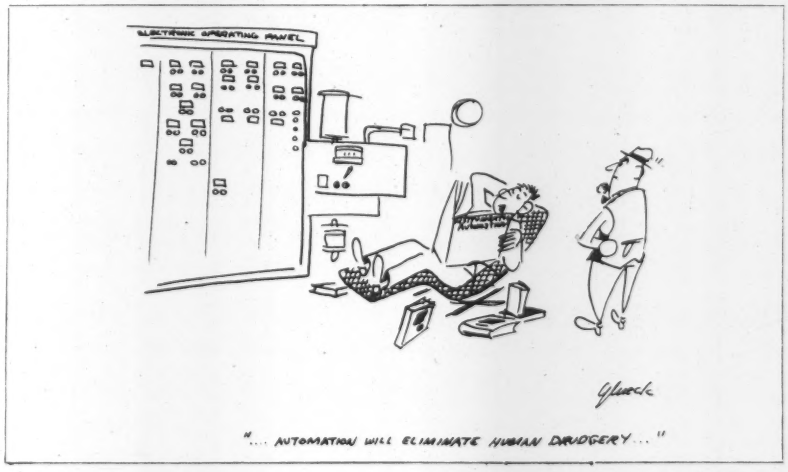
The fourth item concerns your own men and how well they understand the principles of electricity. As I mentioned once before, some fellows are born electricians just the same way as others are born crooks or politicians. Some of your boys will use five bushels of fuses trying to find a short circuit or are caught time and time again on the same type of trouble. About all you can do is to simplify the control and keep after the boys to study up on the subject. You can also hire an electrician but somehow the electrical department smells these men out just as they come in the gate.

I remember one time I undertook to explain to one of the boys how something worked and I used the illustration of the water pump and piping to explain the point. "You see, Joe, the electricity comes into your house on one wire and runs through your lights and other stuff and then goes back out on the other wire back to the power house just like water circulating around through piping, see?"

"Yeah, sure, Boss, but there's three wires coming into my house. What's the other wire for, huh?"

That about sums up the problem. What's the other wire for, eh?

Panhandle Pete



INSTRUMENTS and AUTOMATION News

Principles & Applications ....638 to 654
Stock Report 654
New Plants & Mergers .....662 to 665
People in the News .....667 to 672

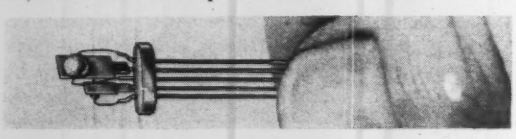
SAMA Supports House Bill, H.R. 6381

CHICAGO, ILL.—Alerting all those who depend upon National Bureau of Standards, certification services, Kenneth Andersen, executive vice president, Scientific Apparatus Makers Association, today called for "greater interest" in support of bill H.R. 6381 which provides for crediting certification fees directly to the account of NBS rather than the general fund of the Treasury.

Instrument makers and the country's scientists who use the certification and testing services were urged to communicate with their own congressmen and Congressman J. Percy Priest, chairman, House Interstate & Foreign Service Committee, to show their interest in the bill's passage during this session of Congress. (See Editorial on page 683).

Tandem Transistor

BURBANK, CALIF.—Dr. H. E. Holman of Marvelco Electronic Division of the National Aircraft Corp., Burbank, Calif. has developed a tandem transistor in which



a common-collector transistor stage is the input device of a second transistor to serve as a useful type of dc transformer. Designated as Mt-1, the two independent elements are housed in a single case and form a two-stage cascade—not a dual transistor. Current gains of 75 db are reported. The high ratio of input to output resistances permit tandem transistors to be driven from high-impedance sources. No extra power is required since the input transistor forms the base leak for its successor. Applications as a high-gain amplifier, oscillator, multivibrator, flip-flop, or switching device are envisaged.

First Closed-Circuit TV Educational Network

POCATELLO, IDAHO—Through a grant by Philadelphia's Jerrold Electronics Corp. and the local Bannock Cable TV, Inc., Pocatello emerges as the first town in the country with a closed-circuit TV network. Gov. Robert E. Smylie of Idaho conducted the first class from Idaho State College (on political science), which was witnessed simultaneously in 11 different elementary schools. The value of this innovation is further enhanced by connecting the college studio to the community antenna system, which picks up three channels on an antenna tower and delivers the programs to subscribers via coaxial cable.

Instrumentation in Venezuela

WASHINGTON, D. C.—A business service bulletin "*Instrumentation in Venezuela*," published by the U. S. Dept. of Commerce, Business and Defense Service Administration, lists the products for which there is a market in Venezuela, and breaks down the share U. S. instrument exporters had in 1952, 1953 and 1954. Their total of approx. $20,800,000 consists of (in round figures) $5,800,000 in 1952, a little under $7,500,000 in 1953 and a little over $7,500,000 in 1954.

Although U. S. instrument suppliers with 65% had a "lion's share" of all Venezuelan imports, competition by Germany, Switzerland, Japan and other countries is now felt.

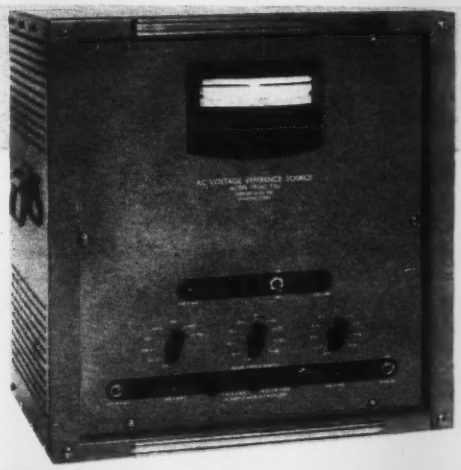
Taking 1954 figures as a basis, about 2/3 went into industrial and process instruments and equipment and 1/3 into scientific and laboratory instruments and equipment. Automatic control devices (including switchboard-panels and control valves in proportion of 2:1) accounted for 3/5 of the former category, while flight, navigation and meteorological, geological and nuclear radiation detection devices made up more than half of the amount in the latter category.

U. S. petroleum firms in Venezuela import practically all their requirements from U. S. suppliers.

BIMCAM

LONDON, ENGLAND.—BIMCAM, the British Industrial Measuring & Control Apparatus Manufacturers' Association, held its 12th Annual Luncheon in January.

Mr. Derek Walker Smith, Parliamentary Secretary of the Board of Trade, addressed the meeting. Membership in the association consists of 35 firms which constitute about 90% of the productive capacity of the industrial instrument industry in Great Britain. Picture shows (left to right) *W. H. Blake*, president of BIMCAM, *D. Walker Smith*, *L. S. Yoxall*, and *Sir Walter Puckey*, past president of the Institution of Production Engineers.



MODEL VRSAC750
0-750 VOLT RANGE

low cost

VOLTAGE REFERENCE SOURCE

FOR RESEARCH LABORATORIES • SCHOOLS • PRODUCTION TESTING
AMPLIFIER GAIN CHECKS • OSCILLOSCOPE CALIBRATION • SERVO TESTING

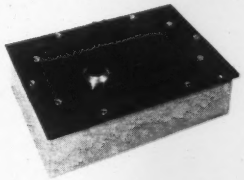
The Sorensen VRSAC750 Voltage Reference Source is a low cost, highly accurate regulator primarily designed for calibrating AC voltmeters in the 0-750 volt range. It is ideal for use with nearly every power meter commercially available.

Its compact design, simple operation and accurate performance make it extremely useful to the laboratory or the production shop. The VRSAC750 is specifically designed for bench-top operation . . . all controls are within easy reach of the operator, and the reference meter is clear, easy to read, and placed at eye level to insure maximum accuracy of adjustment.

Input voltage range	105-125 VAC, 1ϕ
Input frequency	60 ±0.5 cps
Input current	7 amperes maximum
Output voltage	1-799 volts in 1-volt steps
Output voltage accuracy	±0.25% at any voltage in 20°-30°C ambient
Harmonic distortion	1% maximum introduced by the unit

SIZE 20⅜" high, 19⅜" wide, 12" deep WEIGHT 115 pounds net

VRSAC10 — A versatile instrument for lower voltage applications featuring high accuracy at extremely low cost.



Output voltage range	10 mv to 10v RMS in three ranges
Calibration accuracy	±0.1% at full scale at 60 cps
Input voltage	115v ±10%, single phase
Input frequency	50-60 cps; to 400 cps with slightly less accuracy
Waveform	Distortion is negligible
Regulation with load	0.25% max., with load resistance higher than 0.5 megohm
Regulation with line	±0.25% max.

Write today for complete specifications, performance data, and quotations.

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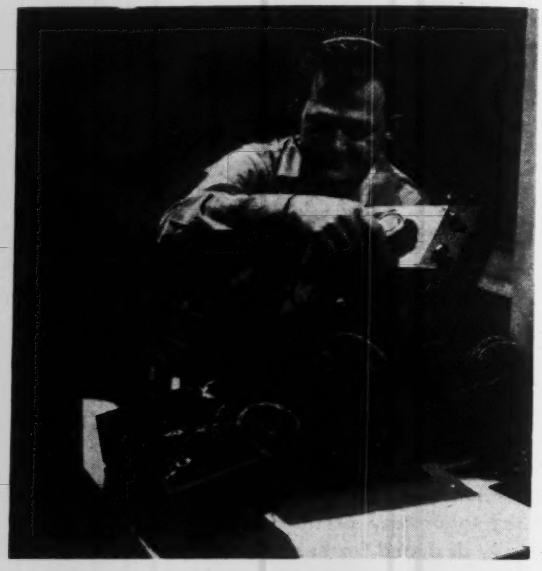
1955 Edison Radio Amateur Award

WASHINGTON, D.C.—GE's annual Edison Radio Amateur Award for 1955 goes to a remarkable personality, Robert W. Gunderson, blind since birth, operator of W2JIO, editor of The Braille Technical Press (an electronic magazine), and designer of more than 30 types of special radio test instruments for the blind. Mr. Gunderson's activities also include teaching 3 night classes at the New York Institute for the Education of the Blind, from which he graduated, and working 3 days as a consultant in a radio parts store. He has translated numerous texts, reference material and tables into braille, and his work is directly responsible for many of the 600 radio-operator licenses that have been issued to blind people, and the many blind who have taken up electronics as an occupation. His activities and warm personality make him an outstanding human being whose life can serve as an object lesson for all. We salute Robert Gunderson on the occasion of his award.



Computer Men Tour Shell

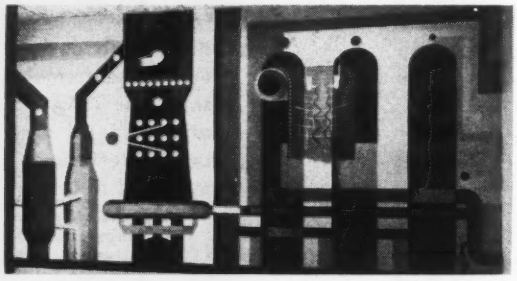
EMERYVILLE, CALIF.—Grant Stockton of Walnut Creek, Mathematician in charge of Shell Development Company's Numerics Laboratory at the Company's Emeryville (California) Research Center, answers questions concerning Shell's ElectroData Computer operations. Listening and asking are members of the 1956 Western Joint Computer Conference held in San Francisco February 7, 8, and 9th. The computer, shown in the background, is used in oil and petrochemical research and development.

EVA

CAMBRIDGE, MASS.—Evaporograph (nicknamed EVA) is a new device built by Baird Associates which uses the infrared-radiation principle to "view" temperatures of a whole surface. Without any electronic circuitry, the device utilizes infrared radiation (which varies in intensity according to temperature) to evaporate parts of an oil film that in reflected light appear as different colors, like oil films on water. The result is a temperature "map" of an entire area. Range of the instrument is from one to several thousand degrees. Its sensitivity is about 0.2 to 0.4C° with exposure time of 30 sec; about 10C° when exposed about 3 sec. Accuracy is ± 2C° in the range of 100-200°C. Measurements can be made either visually or photographically. About a dozen units have been built to date for the military.

Instrumentation Mural

PITTSBURGH, PA.—A mural was recently unveiled in the lobby of The Foxboro Co.'s beautiful new service plant on 2270 Noblestown Rd. in Carnegie, a Pittsburgh suburb. Norman Sandhaus, artist at the company's main plant in Foxboro, Mass., chose industrial instrumentation as his theme, including blast furnaces and stoves in an automated steel mill.



Optical Wedge Filters

CORONA, L.I., N.Y.—Special vacuum techniques have made possible optical linear wedge filters covering the spectral region of 0.240 to 2.9 microns in steps from 0.100 to 0.300 microns. Sizes of the linear wedges vary, with the maximum being 2″x6″. Peak transmissions and halfwidths are within the tolerance of standard 2″x2″ ultraviolet, visible and infrared transmission filters. Applications are in colorimetry, color densitometry, photomicrography, flame photometry, spectrophotometry, and fluorometry. The filters are produced by Axler Associates, Inc., 43 Ave., Corona 68, L.I., N.Y.

Giant Vibration Exciter

DOWNEY, CALIF.—An electrodynamic vibration exciter, affectionately known at North American Aviation's Environmental Laboratory as the "big shaker," has a continuous rated force output of 12,500 pounds and can subject test equipment for supersonic aircraft and guided

Design Factors in Telemetering Systems

Four important points to consider in planning for remote measurement or recording

A BRISTOL APPLICATION NOTE

Telemetering systems provide a proven way to keep tabs on a remotely located process, pipe line, service or utility. In fact, any time remote indication recording, or control is required, telemetering can serve your needs.

Here are the four conditions which must be considered in selecting the best telemetering system for any installation.

1. VARIABLES

Most industrial variables can now be measured, computed, and converted into a form that can be transmitted electrically. Their number and variety influence circuit complexity and the appearance of the receiving panel. Some variables now being successfully telemetered include:

Pressure • Current and voltage • Temperature • Flow • Electrical power • Wind velocity • Liquid level • Motion • BTU's • pH Horsepower • Speed

2. FREQUENCY OF READING

While the majority of telemeter systems in service today are the point-to-point continuous recording type, complex networks and interrelated variables are making sophisticated approaches more and more necessary. The problem usually boils down to these questions: how often is measurement necessary, and what is the least costly way to install and run the system?

Five types of possible hook-ups are:

Continuous recording—where variables are critical and need constant watch.

Intermittent indicating—where variables need only be checked at intervals.

Continuous-Intermittent—where it is possible to separate more critical variables for constant and intermittent telemetering.

Grouped-Multiplex—where several measurements can be transmitted as a group over a single circuit into a "multiplexed" receiver.

Successive-Multiplex—where measuring points over a large area can be "multiplexed" at intermediate locations, then herded to the panel.

3. TERRAIN

The type of interconnecting circuit between the measuring transmitters and central panel usually depends on the terrain: its topography, weather, and degree of settlement. Hence, signals may be carried by one, or by combinations, of the basic transmission media:

Radio—various types of radio can be used to take signals over mountains, deserts, and seas.

Wire—strung wire or leased lines can cover plant, urban, and rural areas.

4. INSTRUMENTATION

Bristol Metameter® Telemeters are eminently adapted to any of the conditions of measurement frequency, variables, or terrain likely to be encountered in telemetering. Transmission can be provided over telephone circuits, carrier current, radio—including microwave, VHF and UHF—and private wires, multiplexing and selective calling. Under all sorts of conditions, thousands of installations, ranging from just a few to hundreds of instruments each, have proven the dependability and reliability of Bristol Telemeters—pulse width (or duration), differential transformer, and voltage types, as well as pneumatic systems.

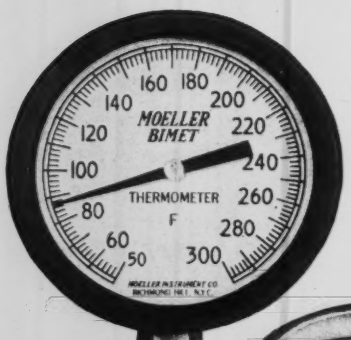
For more information on how Bristol Telemeters can benefit *you*, write THE BRISTOL COMPANY, 113 Bristol Road, Waterbury 20, Conn. 5.44

TYPICAL RECEIVING CENTER in multiplexed telemetering system.

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

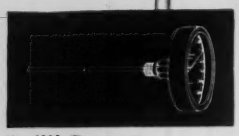
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **18** on inquiry card.



No. 4500
Straight Connection
5" Diameter Brass Case
in Black Finish

No. 4250
Angle Form Connection
3" Diameter Stainless
Steel Case



No. 4000
Back Connection
5" Diameter Brass Case
in Black Finish

You get dependability PLUS in Moeller Bimet Dial

thermometers

because—the design and manufacture of temperature measuring instruments has been our business since 1867.

The sturdy construction, coupled with easy-to-read dials assure continued top performance in accuracy and reliability.

Specify and install Moeller Bimets . . . built upon 90 years of experience. For information mail the coupon, today.

MOELLER INSTRUMENT COMPANY
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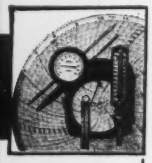
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities



Gentlemen: Without obligation, please send me Moeller Bimet Thermometer Bulletin No. 225 B.

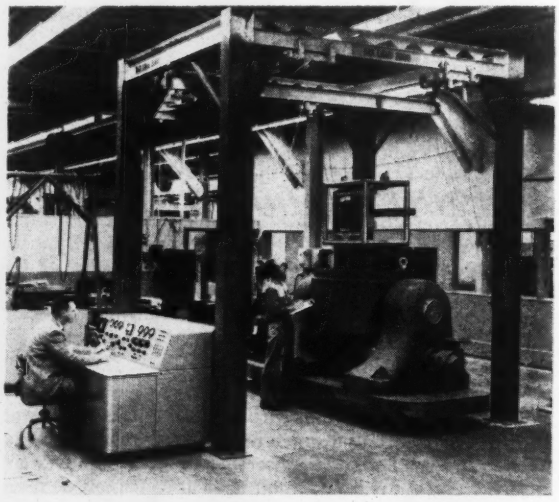
NAME .....

FIRM .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

For more information circle **19** on inquiry card.

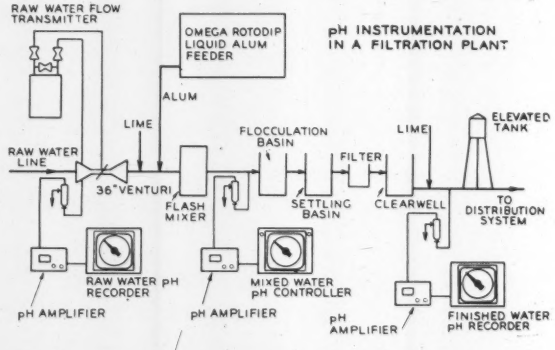


missiles to 45 times the force of gravity. MB manufacturing Co. of New Haven, Conn., supplied the equipment whose operating frequency range is from 2 to 2,000 cps. Test items are mounted on a big magnesium table which is shaken electromagnetically and gives a sinusoidal motion. Automatic direct servo controls maintain a desired "g" level.

Filter Plant Control

WATERBURY, CONN.—A large municipal water filtration plant in the South recently solved a difficult pH control problem with an interesting automatic control system utilizing both flow telemetering and standard pH control mechanisms.

The raw water supply of the filtration plant varied widely both in pH and in flow rate as it was pumped



into the plant. Accurate control of pH was necessary to achieve efficient flocculation, but the two variables made manual control difficult. The problem was solved by a dual control system which took into account both pH and flow rate.

The plant installed a B-I-F Omega Rotodip automatic feeder for dispensing alum solution into the raw water just before it enters the flash mixer. This feeder is made up of a series of buckets or dippers on a wheel which rotates in such a way that the dippers scoop up the alum from a storage reservior. The alum then flows into a small reservior and into the raw water line.

Automatic control of this feeder with respect to flow is initiated by a Bristol Metameter flow-rate telemeter

For research . . . for quality control . . . for raw material inspection —

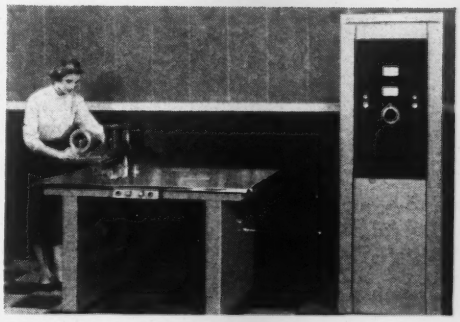
New G-E x-ray diffraction unit fits any analysis program

FOR fast, accurate qualitative or quantitative analysis of solids or liquids, the General Electric XRD-5 offers a host of new advantages.

New versatility! Basic components allow you to start with high-standard minimum equipment . . . add features as needs grow. Double duty! Twin-tube operation achieved simply by adding a second tube and ma control. New accessories! A full range of new accessories enables users to fully exploit the advantages offered by diffraction and emission technics.

The XRD-5 works equally well when analyzing large or minute samples. As for speed, one research laboratory cut its time on a product identification test from two days to five minutes—one half of one percent of the time formerly required by conventional chemical analysis.

For complete information on the XRD-5, consult your G-E x-ray representative. Or write X-Ray Department, General Electric Company, Milwaukee 1, Wisconsin for Pub. BL-44.



General Electric diffraction unit equipped for minimum film technics. Added equipment (additional tube, shockproof case, and ma selector) provides facilities for up to six instruments at one time. Further additions will equip the unit for simultaneous film- and direct-measurement technics.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Manufacturers of the only compete x-ray line

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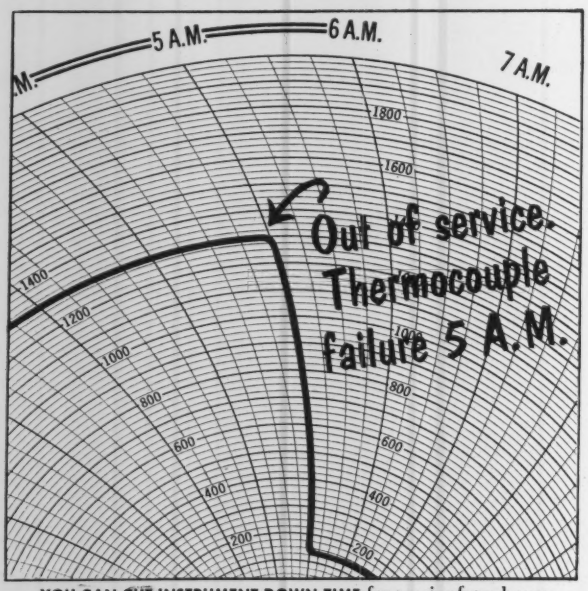


YOU CAN CUT INSTRUMENT DOWN-TIME for service from hours to minutes in most cases with an adequate supply of Bristol thermocouples and pyrometer accessories.

How much can interrupted pyrometer service cost you?

Now's the time to worry—before it happens—about what interrupted pyrometer service can do to your production schedules, cost figures, and quality controls.

And now's the time to lay in a supply of Bristol's pyrometer supplies and accessories to cut down-time to a minimum. Bristol's complete line of thermocouples, protection tubes, radiation-unit accessories, refractory insulators, mounting fixtures, thermocouple wire, and extension wire, switches, ink, and charts, are available in a wide selection of interchangeable sizes and types to fit all standard installations.

They're backed by Bristol's 51 years experience in industrial pyrometry. We've built thousands of pyrometers for every application—in iron, steel, non-ferrous metal smelting and refining; in petroleum, chemical, ceramics, glass, paper, and food-processing industries and in power, heat and incineration utilities.

You'll find these pyrometer supplies completely described in our 56-page Bulletin P1238, together with technical data on selection, installation, maintenance, and calibration. Write for your copy today. The Bristol Company, 154 Bristol Rd., Waterbury 20, Conn.

FREE BULLETIN P1238. Tells how to select, install, calibrate and care for thermocouples and pyrometer accessories.

6.18

BRISTOL *Points the Way in Human-Engineered Instrumentation*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **21** on inquiry card.

NEWS —CONTINUED

transmitter located at a Venturi in the flow line. The flow measurement taken here is transmitted to a time-duration or impulse-type controller-receiver at the feeder, which regulates a belt-shifting device between the feeder drive motor and the dipper wheel.

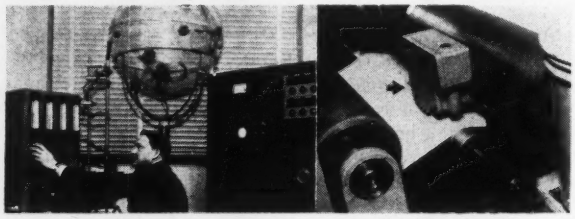
In addition, a Bristol Dynamaster pH recorder-controller with adjustable proportional band and automatic reset is used. Electrodes are installed just downstream from the flash mixer. Change in pH of the water controls the speed of the alum dipper wheel rotation. As the pH increases, the dipper wheel rotates faster, adding more alum; as the water becomes more acidic, the speed decreases proportionally.

With the dual-control method compensating for changes in both flow rate and initial pH, the water flowing into the settling basins is held at a uniform pH for flocculation and settling.

News Bits

NATIONAL SCIENCE FOUNDATION has made 164 grants totaling about $3,240,500 (during the quarter ending December 31, 1955) for the support of basic research in the natural sciences, for conferences in support of science, for exchange of scientific information, and for summer institutes for refresher training of high school and college undergraduate science teachers. Since the beginning of the program in 1951, 2039 such awards have been made, totaling more than $24,000,000.

THE AEROSOLOSCOPE, invented by Nelson E. Alexander, Army Chemical Corps engineer, is a new germ counter which may give instant warning of enemy biological warfare attack. It also may find use in tracing source of air pollution, such as smog.



Alexander's germ counter

The "Registron"

REGISTRON is the trade name of a new electronic system for automatic control of cutoff and color register on rotary presses marketed by Champlain Co. of Bloomfield, N. J. A web scanner, a photo-electric phase detector and a control unit assure accurate registration of the web.

CRUCIBLE STEEL CO. OF AMERICA recently celebrated the fiftieth anniversary of pouring the first heat of electric melted steel in America. In 1955 total U.S. electric furnace capacity accounted for 8.6% of the total U.S. steel capacity.

CLARY CORP. has initiated a Supplementary Technical Engineering Program (STEP) to give its engineering personnel the opportunity for formal engineering training with scholastic credit for undergraduate work for students who wish to work toward a degree.

Continued on page 649

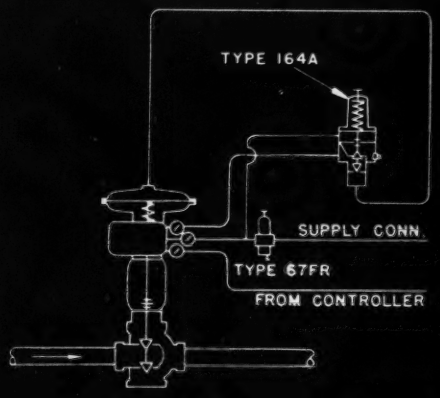
Circle **22** on inquiry card. ⟶

FISHER® SERIES 164

For "Gadgeteering" Control

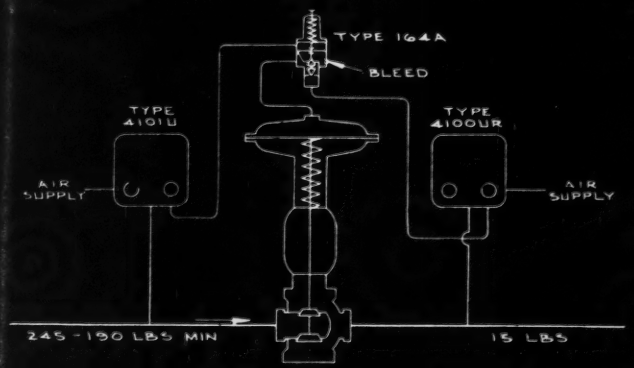
SUCH AS

TWO-WAY ACTION for SAFETY LOCK-UP

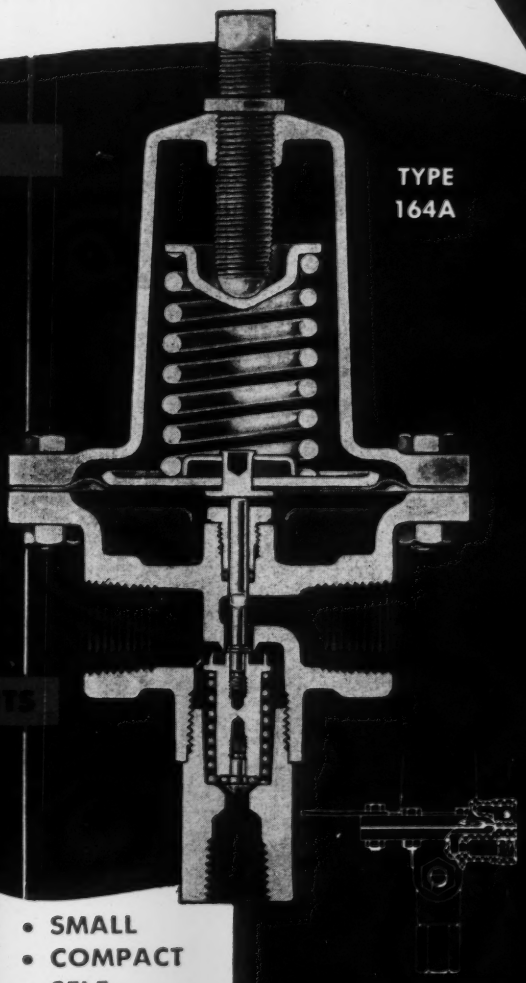


Lock-up system using Type 164A to close air circuit to diaphragm of main valve in case of plant air failure. Main valve will be held in position at time of supply pressure failure.

THREE-WAY ACTION for SWITCH AIR CIRCUITS



Pressure reduction normally handled by 4100UR Wizard. If inlet pressure to main valve falls below a predetermined amount Type 4101U snap-acting Wizard bleeds pressure off Type 164A switching valve causing 3-way valve to change position so as to close control line pressure and bleed main valve diaphragm pressure to atmosphere. Main valve will stay closed until inlet pressure is restored to desired amount.



- SMALL
- COMPACT
- SELF CONTAINED

Side view of Type 164 Showing ¼" Control Line Connection. Control Chamber is separate from body chamber.

SIZES ¼" or ½"

CONTROL SPRING RANGES PSI	PRESSURE CHANGE ON DIAPHRAGM FOR FULL VALVE STROKE, PSI
3 to 15	2
5 to 20	2½
5 to 35	4
30 to 60	5¾

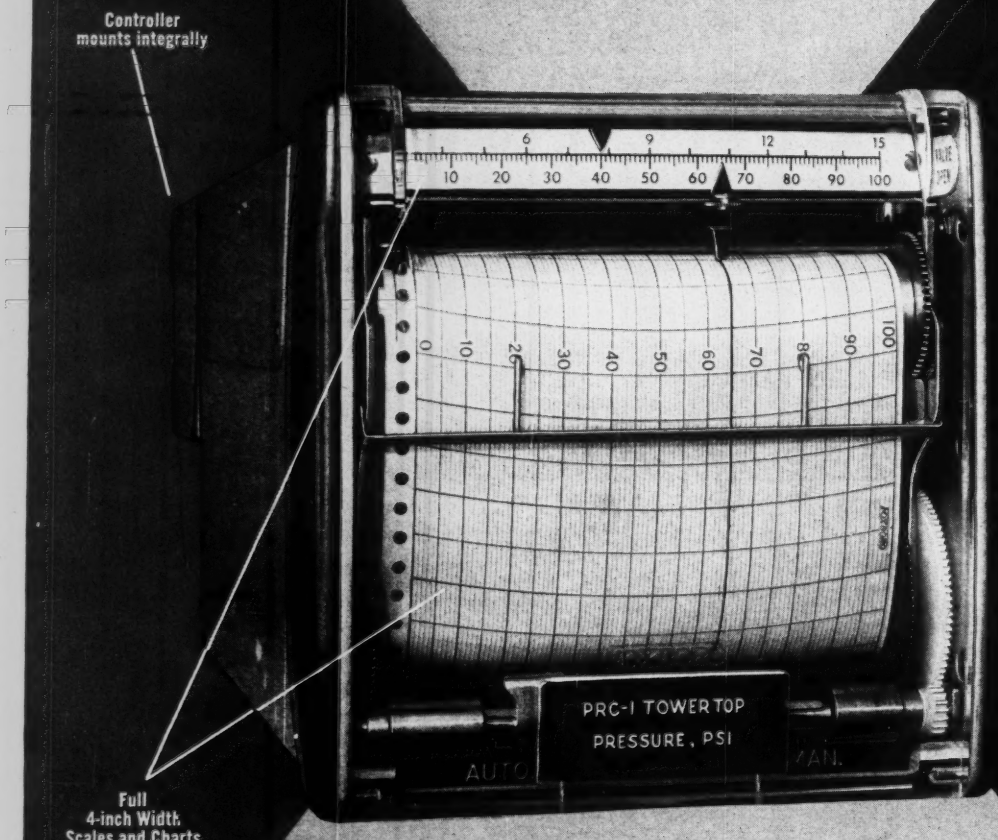
MATERIALS

Zinc die cast body and spring case, composition diaphragm and valve disc.

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA
CANADIAN PLANT: WOODSTOCK, ONTARIO
WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

NOW...

compactness with nothing sacrificed!



Models to Meet All Your Specifications

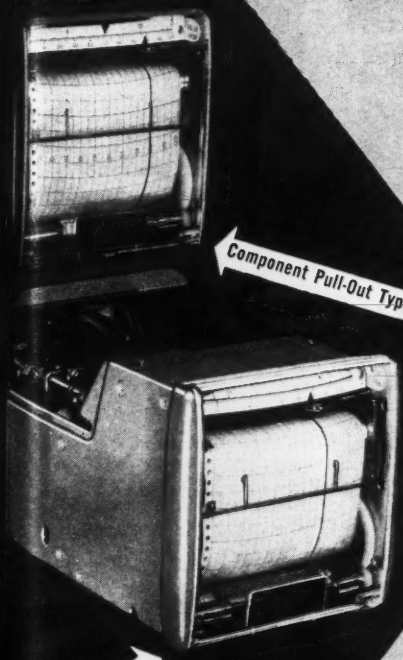
In all the following CONSOTROL instruments, recorder and indicator units can be easily converted in field.

- Recording Control Station with automatic/manual transfer
- Recording Control Station with manual loading only
- Recorder — single or two pen
- Indicating Control Station with automatic/manual transfer.
- Indicating Control Station with manual loading only
- Indicator — single or two pointer

For more information circle **23** on inquiry card.

CONSOTROL

small-case panel instruments



Here's the "tops" in centralized recording and control efficiency! CONSOTROL Instruments require the minimum of valuable panel space, yet provide unsurpassed operator convenience, visual accuracy, and ease of maintenance . . . maintain the highest standards of precision and dependability. For example: the simple CONSOTROL method of switching from automatic to manual control requires no memory or extra operations . . . never "bumps" the process. All CONSOTROL charts and scales are full 4-inch width for greatest visibility . . . highest accuracy. When it comes to servicing, there's plenty of "finger room" . . . all parts are uncrowded and easily removable. And just compare inking requirements with other designs. CONSOTROL needs ink filling only once or twice a year! These are only a few of CONSOTROL's advanced design features — available in both fixed-mounting and full pull-out type instruments. Get the complete story. Write for Bulletin 13-18. The Foxboro Company, 464 Neponset Avenue, Foxboro, Mass., U.S.A.

FOXBORO

REG. U. S. PAT. OFF.

Consotrol Process Control

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle **23** on inquiry card.

BURNELL

continues to offer the most advanced line of reliable MIL-T-27 inductors, filters and delay lines.

Variable Inductors
- inductance values up to 1000 henrys
- variable over a range of ± 10%
- high Q, small size
- for low-frequency tuning applications

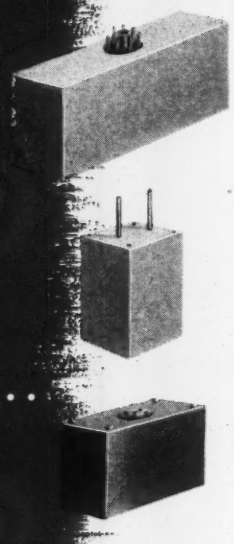
Molded Toroids
- inductance precision within 1%
- high Q because molded construction minimizes distributed capacity
- subminiature to standard sizes
- compact and sturdy

Subminiature Adjustoroids
- precise continuous adjustment of inductance over a 10% range
- no external control current needed
- hermetic sealing
- low cost

Encapsulated Toroids
- hermetically sealed
- high Q
- center mounting permits stacking
- miniature to standard sizes

FOR YOUR CIRCUIT NEEDS...

Write to Dept. K for application or performance information



Crystal Filters
- nominal cost
- excellent delivery
- frequency range 50 kc to 5000 kc
- high stability

Tom Thumb Telemetering Filters
- miniaturized for guided missiles
- high temperature stability
- designed to withstand shock and vibration
- hermetically sealed

Delay Lines
- for audio and low radio frequency applications
- constancy of time delay
- flat frequency response
- low insertion loss

BURNELL & CO., INC.
PACIFIC DIVISION
720 MISSION STREET • SOUTH PASADENA, CALIFORNIA

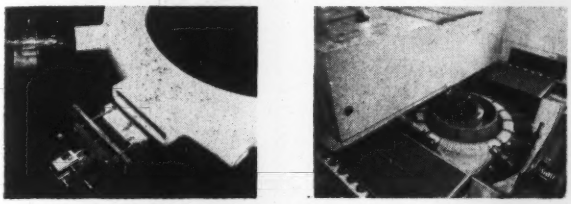
For more information circle **24** on inquiry card.

NEWS—CONTINUED

MINNEAPOLIS-HONEYWELL has introduced electronic automation in Chicago's lake-front skyscraper of the Prudential Insurance Co.—to furnish controlled air conditioning influenced by factors such as rapid outdoor-temperature changes, thousands of people streaming into the building in the morning, idling night operation, etc.

NARDA CORP. has developed a system whereby inexperienced personnel can make accurate pre-flight tests of airborne weather radar.

HIGH-ENERGY X-RAY research carried out with the NBS's 50-Mev betatron and the 180-Mev synchrotron has



NBS Betatron and Synchrotron

provided valuable data for nuclear physics, medicine and industry. The data has been summarized in a recent NBS report.

GENERAL PRECISION LABORATORY is equipping 2 bombers for the U.S. Weather Bureau with a photo panel (for continuous photographing of 21 data channels, including time, air, speed, wind direction and speed, etc.) and a digital recorder (for recording 9 information channels of correlated data) to study hurricane behavior.

NEW INCANDESCENT LIGHT BULB developed by General Electric, said to produce from 6 to 15% more light per watt power, can save American consumers more than $100 million annually.

EUROPEAN TECHNICAL OBSERVATION GROUP is being set up by Armour Research Foundation of Illinois Institute of Technology to funnel ideas and techniques of potential value to participating companies in the United States.

ELECTRODATA's DATATRON is being used by the General Insurance Co. of America in its Seattle headquarters to process the paperwork for hundreds of thousands of policy holders.

GAS-LIQUID PARTITION CHROMATOGRAPHY, a new technique, has been perfected by Gulf Oil laboratories to separate gases and liquids whose boiling points nearly coincide.

RADIATION MONITOR SERVICE is now offered by St. John X-Ray Laboratory of Califon, N. J. A film (sensitive to beta and gamma radiation and neutrons) contained in a wrist badge holder monitors whether the person has been exposed to such radiation. Shipped to the laboratory weekly, overexposure is reported back immediately.

A NATIONAL OBSERVATORY—long the dream of American astronomers—will be begun within next two years. *First of its kind in United States, the observatory probably will be run jointly by several institutions.* It would give astronomers from all parts of the country

TESTA

PRECISION LENSES

optical components, sub-assemblies, optical instruments and test equipment

Internal Inspection Borescopes
Microscopes

military and commercial contract work. quotations submitted promptly

phone: Cumberland 3-6022
TESTA MFG. CO.
10122 *rush st. el monte, calif.*

Dealer Inquiries Invited
For more information circle **25** on inquiry card.

Why "CHOKE" your soldering iron?

— just "CRADLE" it with a

HEXACON
HATCHET SOLDERING IRON

The operator has to "choke" the conventional straight iron to hold it, whereas the HEXACON HATCHET IRON "cradles" in the hand with no perceptible grip whatsoever — *thus relieving hand strain* and eliminating the "heavy hand", the cause of poorly soldered joints. Because HEXACON HATCHET IRONS are *perfectly balanced* in weight, they enable the operator to solder in a natural position and relieve fatigue of arm and back.

Send for new circular No. 70H giving more details and comparative competitive performance data.

A COMPLETE LINE OF HATCHET IRONS BY HEXACON
—*Originator and Pioneer*

CAT. NO.	WATTS	TIP DIA.	PRICE
25H	25	1/8"	$ 6.00
26H	30	3/16"	6.00
30H	60	1/4"	6.25
70H	80	3/8"	10.25
100H	100	3/8"	11.00
150H	150	3/8"	11.75
151H	175	1/2"	12.25
200H	200	5/8"	12.75
300H	300	7/8"	16.25

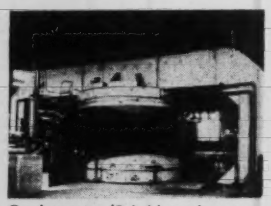
HEXACON ELECTRIC COMPANY
506 West Clay Ave., Roselle Park, New Jersey

INDUSTRY'S No. 1 HEXACON SOLDERING IRON

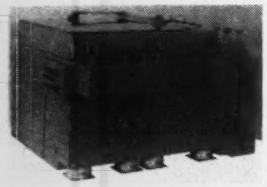
For more information circle **26** on inquiry card.

much better research facilities than their institutions can afford separately.

BALDWIN-LIMA-HAMILTON-built SR-4 strain gages will guard the bolts of the rebuilt cyclotron at the University of California at start-up next June. The greatly increased magnetic forces of the largest proton beam producer in the world (750 Mev) may cause it to fly apart if not closely watched.



Cyclotron w/B-L-H strain-gages



Mark 91—Mark 92 computer

FORD INSTRUMENT CO., Div. of Sperry-Rand Corp. was revealed by the U.S. Navy as having furnished the Mark 91-Mark 92 computer installed on the U.S.S. Carronade, the new inshore fire-support ship which can fire rockets against enemy ground troops.

LOCKHEED AIRCRAFT CORP. will invest $20,000,000 in the next three years for advanced missile studies in conjunction with Stanford University, which will include a series of new research laboratories.

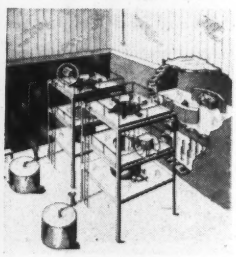
A DICTIONARY OF COLOR NAMES was published by the NBS to define some 7500 names in simple, accurate terms. With the aid of the Inter-Society Color Council (ISCC) the vocabularies used in fields such as women's clothing, philately, horticulture and automobiles were correlated.

THE SHEFFIELD CORP.'s new $250,000 Ely Whitney Metrology Lab was dedicated last month in Dayton, Ohio, to give private industry precise measurement facilities comparable to those of the world's leading government standards laboratories.

FRANKLIN INSTITUTE in Philadelphia is building an ultra-long infrared cell to be used in air-pollution studies in the Los Angeles area.

BATELLE MEMORIAL INSTITUTE has completed the second major unit of its new Atomic Energy Center.

Reactor control Panel.



Reactor room

The new reactor development laboratory will serve industry in research on power production and atomic propulsion units.

WHEELCO INSTRUMENTS DIV., Barber-Colman Co., furnished temperature controls for the world's largest horizontal injection molding machine producing refrigerator door panels. Built by Watson-Stillman Co., Div. of

Continued on page 654

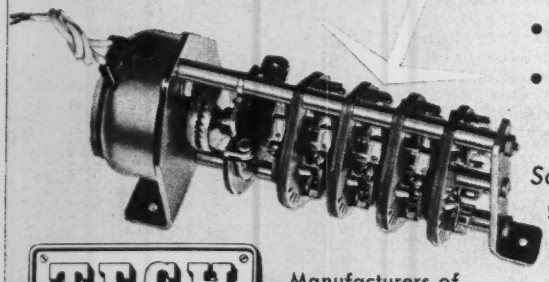
For AUTOMATION

• TELEMETERING
• REMOTE CONTROL

This Tech Lab stepping switch is built around the well known Type 2A tap switch—still unmatched for quality and long life. The Type 20A will handle more voltage and current than other stepping switches. Ideal for rotary relays because there's never any chattering due to vibration. A perfect component for Automation, Telemetering and Remote Control Equipment.

Type 20A Specifications:

- Standard types furnished with 1-7 decks and 1-4 poles per deck
- Switches may have up to 24 contacts
- Contact Resistance: 3-4 milliohms
- Contact Material: Silver plated brass or silver alloy
- Current carrying cap.: 3 amp.
- Size: 1¾" dia.



Type 20A
Solenoid Operated
STEPPING SWITCH

TECH LABORATORIES, INC.

Manufacturers of
Precision Electrical Resistance Instruments
PALISADES PARK, NEW JERSEY

For more information circle **27** on inquiry card.

Accurate temperatures —at a GLANCE!

NEW
PYRO SURFACE PYROMETER

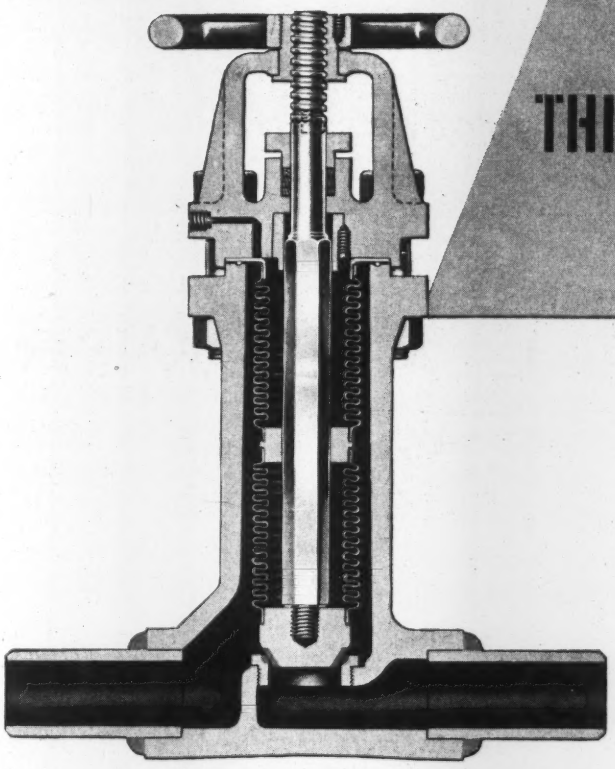
—unsurpassed in accuracy, it is quick-acting, light-weight and rugged. Features large 4¾" direct reading dial. Measures both surface and sub-surface temperatures with selection of thermocouples and extension arms. Has cold-end junction compensator (operates automatically) and shielded steel housing. Available in five standard ranges: 0-300° F. to 0-1200° F.; also special and sub-zero ranges. Write for free Catalog #168.

PYROMETER INSTRUMENT CO.

Bergenfield 4, New Jersey

Manufacturers of Pyro Optical, Radiation, Immersion and Indicating Pyrometers for over 25 years. Ask for Catalogs.

For more information circle **28** on inquiry card.



WHAT MAKES THIS PACKLESS VALVE LEAK-PROOF?

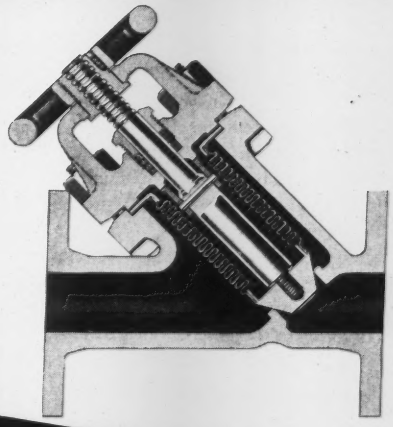
Even at pressures of 500 psi and temperatures of 1000°F., Sylphon Packless Valves prevent corrosive or flammable fluids from leaking and creating hazards.

How? Simply by using a bellows seal around the valve stem . . . not an ordinary bellows, but a SPECIAL SYLPHON BELLOWS that gives added protection and safety. Here are some of its outstanding features:

- No weak seams to open and leak.
- Cold-worked and hydraulically formed for resiliency and long life.
- Extra thick sidewalls . . . 2 or more plies of metal for extra strength.

In Sylphon Packless Valves you get double protection . . . the bellows seal *plus* regular packing which functions only in an emergency.

There's a wide selection of sizes and types. Sylphon Packless Valves are available in brass, bronze, cast iron or stainless steel. Special types are available for specific applications in the chemical and atomic industries. For complete information, return the coupon below.



Robertshaw-Fulton
CONTROLS COMPANY
FULTON SYLPHON DIVISION

Robertshaw Fulton Controls Co.
FULTON SYLPHON DIVISION
Knoxville 1, Tennessee

Send Bulletin 813-GL describing all Sylphon Packless Valves.

Name_____

Company_____

Address_____

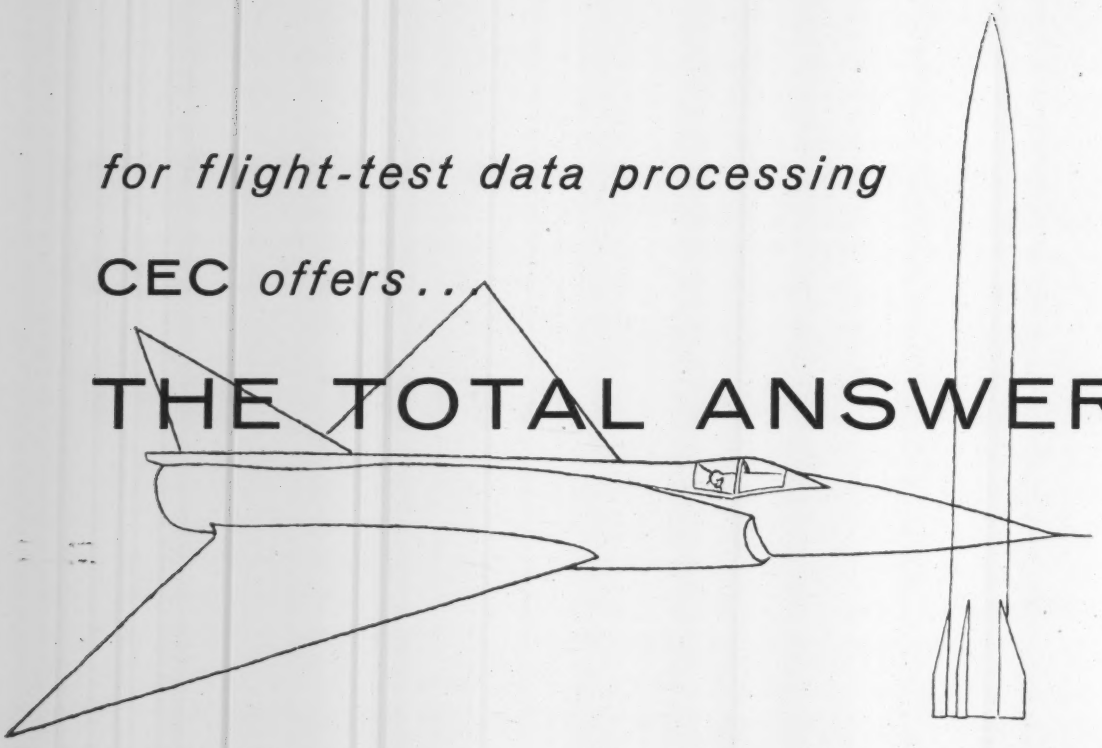
City_____ **State**_____

For more information circle **29** on inquiry card.

for flight-test data processing

CEC *offers . .*

THE TOTAL ANSWER



It's time somebody said it: *magnetic-tape equipment by itself is not the whole answer!* That's why Consolidated Electrodynamics . . . while it offers the most advanced and complete line of magnetic-tape flight-test instrumentation . . . is stressing this policy:

"We're selling *Data Processing,* not components alone."

Since a single test flight of today's intercontinental bomber involves about 1½ million data points, quick and complete solutions to the enormous problems of data processing are imperative. Faster and more accurate data processing reduces design time and means better planes in the air . . . *sooner.*

Consolidated Electrodynamics, following its policy of selling the "Total Answer" to your problems, offers equipment literally covering the span from phenomena to digits. Whether your requirements can be satisfied by standard units or your test objectives demand development of special equipment, CEC will work in any of three general brackets . . .

1st . . . **STANDARD COMPONENTS** of the comprehensive CEC DataTape line, all designed specifically for flight-test work. Shown on the opposite page, the DataTape line includes recorders and record amplifiers, as well as supporting units such as signal modulators and coders, range-time generators, automatic calibrators, and complete ground-playback and demodulating equipment. (Standard equipment of other manufacturers can also be supplied when needed to complete a data-processing system.)

2nd . . . **SEMI-STANDARDIZED SYSTEMS** (designed by CEC's Systems Division) of magnetic-tape data-processing systems, each designed to solve a specific set of test problems but easily modified to cover unique problems arising from new vehicle designs, new parameters, new test objectives.

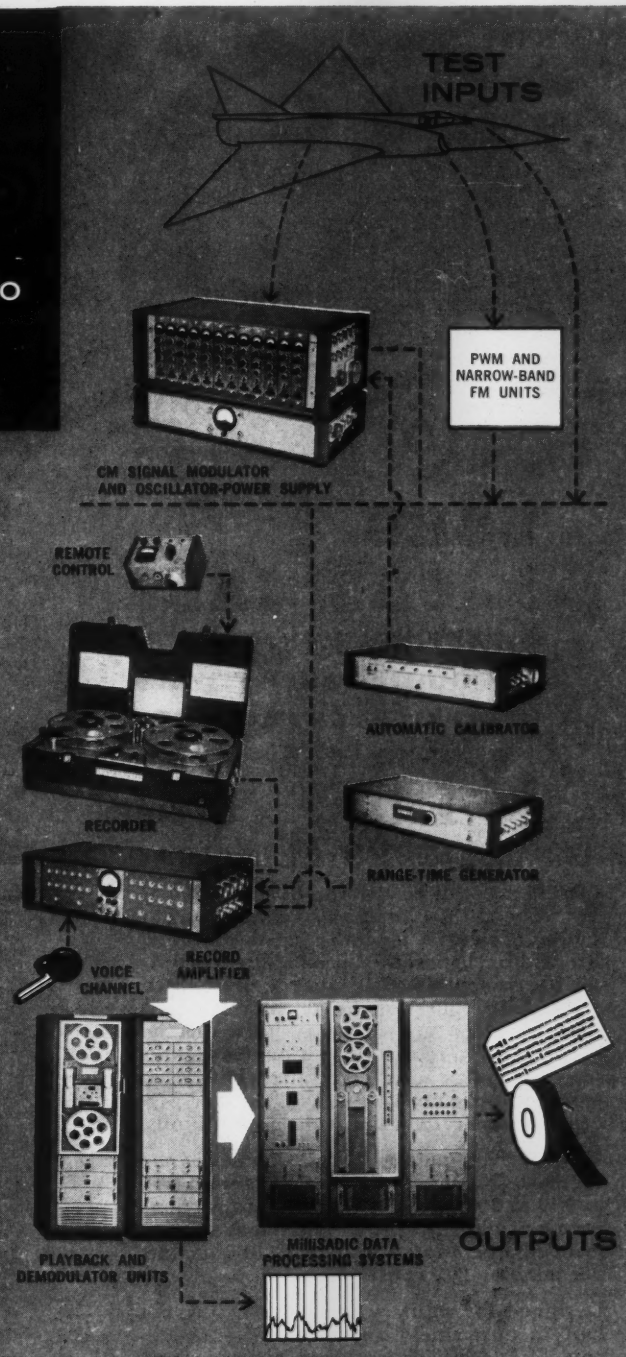
3rd . . . **RESEARCH AND DEVELOPMENT** (through Consolidated's new Advanced Electronics Data Laboratory) for those cases where present equipment of CEC's own manufacture or that of other companies will not adequately accomplish the test mission or the type of data processing necessary.

Phase 2 of "Operation Data," Consolidated's famous mobile show trailer which travelled over 23,000 miles in 1953, will be in your area soon. Phase 2 will feature a complete display of DataTape and the companion automatic equipment with which CEC is helping America's aircraft and missile designers break the flight-test bottleneck. Watch for it soon!

For more information circle **30** on inquiry card.

"Test Variables to Digits"

. . . Consolidated's answer to flight-test bottlenecks



Consolidated's long-standing leadership in flight-test instrumentation includes the pioneering of the "systems" approach—the designing of instrumentation for the *Total Answer* rather than just components. "Test Variables to Digits" is literally true as a description of CEC's products and experience.

From CEC's Transducer Division have come some of today's most widely used devices for *sensing* the parameters of supersonic flight. DataTape, shown at the right, was developed specifically for the problems of flight-test data *handling*, is a coordinated family of instruments ready to serve as a proven nucleus for a wide variety of data-processing systems. For the vital step of *digitizing* test data, CEC developed the SADIC and MilliSADIC group of instruments and systems—today's most comprehensive, *proven* line of analog-to-digital data-processing units.

The Consolidated Systems Division is ready to add to these basic units whatever output devices are needed to accomplish the test mission. These range from CEC's own MilliSADIC, ground playback and demodulator units, and recording oscillographs to the equipment of other manufacturers, such as oscilloscopes, spectrum analyzers, and chart recorders.

For the Total Answer to your data-processing problems . . . whether in connection with today's or tomorrow's aircraft and missiles . . . it will pay you to call in the experienced engineers of Consolidated Electrodynamics. There's no obligation. And for the story of DataTape, send today for Bulletin 1561-X10

Consolidated Electrodynamics Corporation

formerly Consolidated Engineering Corporation

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena, California

Sales and Service Offices in: Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.

For more information circle **30** on inquiry card.

BORG MICRODIAL

DIRECT READING THROUGH 3600° TO A DIGITAL ACCURACY OF 1 PART IN 1000.

FITS ANY MULTI-TURN DEVICE HAND OR SERVO OPERATED

The new direct reading Borg Microdial Model 1301 practically eliminates human error because it was designed for forced fast reading. Laboratory, production and processing controls become more accurate when clear, sharp, figures on the specially designed Borg Counter are observed through the focal-point window. Borg Counter figures are seen against a dull black background to provide maximum contrast for instant perception under difficult reading conditions.

The specially designed Borg Counter in the Model 1301 Borg Microdial reads from 000 to 999 to 000 in 3600 degrees of continuous rotation with no stops. Maximum recommended operating speed is 10,000 counts per minute (100 rpm).

Designed for military application, it has a built-in dust shield and clear-vision, wide-angle window for accurate reading from almost any position in front of the dial.

The Model 1301 Borg Microdial is compact. It measures only 1-3/4" in diameter and 1-5/8" in height and occupies no more panel space than the Micropot it controls.

WRITE FOR CATALOG SHEET BED-A31

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

For more information circle **31** on inquiry card.

NEWS—CONTINUED

H. K. Porter Co. for General Machine and Tool Works it works with 20,000 psi at cycling speeds of 50 seconds.

SEMIMICRO DILUTION VISCOMETER developed by NBS is suitable for dilution and reruns of solutions, thus valuable for molecular weight studies of polymers.

ARNOLD ENGINEERING DEVELOPMENT CENTER, Tullahoma, Tenn. is installing three of Remington-Rand's UNIVAC Scientific systems (ERA-1102) as aids in analyzing data, including wind-tunnel speeds up to 7000 mph.

ATOMICS INTERNATIONAL, a Division of North American Aviation, recently exhibited 3 models of nuclear reactors for medical, industrial and power applications at the National Rural Electric Cooperative Association meeting in St. Louis.

DAGE TELEVISION DIVISION has furnished a closed-television system for less than $2200.00 which affords the shearman in the No. 3 Slabbing Mill of Great Lakes Steel Corp. (Detroit) accurate cuts of slabs.

Stock Report

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York

New York Stock Exchange:

Security	Price Range for 1955-56 Thru February 29 High	Low	As of February 29 Last
Aeroquip Corp.	17 1/2	6 1/2	13 1/4
American Chain & Cable	46 3/8	35 1/2	40 3/4
American Mach. & F.	39 7/8	23 1/4	25 3/4
American Mach. & M.	41 3/8	27 1/2	37 7/8
American Optical	53 1/4	35 1/2	38
Beckman Instruments	30 3/4	19 3/8	29 1/4
Bell & Howell	42 1/4	28 1/4	32
Bendix Aviation	59 1/2	45	55 1/2
Bulova Watch	25 3/8	20 3/4	21 7/8
Burroughs	34 1/4	22 7/8	32 3/8
Clevite	25 3/8	20 1/2	21 7/8
Dobeckmun	38 7/8	30 1/4	33 7/8
Gamewell	39	25 5/8	29 1/4
General Inst.	13	7 5/8	8 7/8
General Prec.	71 1/2	36 1/2	50 1/2
General Time	39 3/4	29 1/2	31
Hamilton Watch	25 1/4	18 1/4	21 5/8
International Business Mach.	450	349	409
Minneapolis-Hon.	70	50 1/8	66 5/8
National Cash Reg.	47	33 7/8	38 3/4
Radio Corp.	55 3/8	36 3/4	44 7/8
Raytheon	25 3/4	13 7/8	17 3/8
Robertshaw-F.	33 5/8	25	26
Sangamo Electric	33	25 1/2	32 1/2
Sperry Rand	29 5/8	21	26 3/8
Square D	61 3/8	40 1/2	59
Starrett, L.S.	50	40 3/4	47
Sylvania Elec.	49 7/8	41	47 5/8
Telautograph	37 1/2	25 1/2	29
Texas Inst.	16 7/8	10 1/8	12 5/8
Underwood	43 1/8	33	36 7/8

American Stock Exchange:

Security	Price Range for 1955-56 Thru February 29 High	Low	As of February 29 Last
Air Assoc.	12 3/4	7 3/4	10 1/8 - 10 1/2 (1)
American Meter	41	32	38 3/4
Benrus Watch	10 7/8	9 3/8	9 7/8
Breeze Corp.	9 3/8	5 3/4	7 1/2
Consolidated Electrodynamics	31 1/4	20	23 3/4
DuMont Labs.	17 1/8	8	8 3/8
ElectroData	17 7/8	10 3/8	15
Fairchild, C. & I.	37 1/4	21	22 1/2
Int'l Resistance	12 3/8	5	7
Lear Inc.	13 3/8	7 1/4	9 1/8
Nat'l Res. Corp.	33 1/4	17 3/8	18 3/8
Neptune Meter	34 7/8	21	31 1/2
New Haven Clock	4 1/8	2	2 3/8
Norden-Ketay	19 1/2	11 3/8	12 3/8
Pneumatic Scale	31	25 1/2	25 1/2 - 26 1/4 (1)
Servomechanisms	13 3/8	8 1/4	9
Wallace & Tiernan	26 7/8	19 1/2	20 7/8
Waltham Watch	2 7/8	1 3/8	2 1/8

(1) Bid - Ask price, no sale.

INSTRUMENTS and AUTOMATION Events

For other computer Events see page 725.

April 25-27

Symposium on Nonlinear Circuit Analyses II, Engrg. Societies Bldg., 33 W. 39th St., New York, N. Y., sponsored by Microwave Research Institute of the Polytechnic Institute of Brooklyn.

April 25

Symposium on "Control Systems Engineering—Electronic Controls In Industry" sponsored by the Wilmington Section, ISA. For information contact W. G. Schmick, Minneapolis-Honeywell Regulator Co., Orange St., Wilmington, Del.

April 26-27

Technical Conference on Electrical Recording and Controlling Instruments sponsored by AIEE, ASME and ISA cooperating, to be held at the Hotel Bradford, Boston, Mass. For information contact E. T. Davis, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

May 1-3

Electronic Components Symposium at the Auditorium of the U. S. Dept of Interior, Washington, D. C. For information write A. W. Rogers, Chairman, Signal Corps, Ft. Monmouth, N. J.

May 6-9

2nd National Flight Test Instrumentation Symposium sponsored by North Texas Section ISA & Flight Test Instrumentation Sub-Committee, Fort Worth, Texas.

May 8-11

Metals Engineering-AWS Conference sponsored by the American Society of Mechanical Engineers, Hotel Statler, Buffalo, N. Y.

May 10-11

4th Annual Meeting of the Operations Research Society of America, Sheration Park Hotel, Washington, D. C. Program Chairman: Hugh J. Miser, Rt 2, Box 211, Vienna, Va.

May 14-16

8th Annual National Conference on Aeronautical Electronics, sponsored by the IRE, Dayton Biltmore Hotel, Dayton, Ohio. For information write P. O. Box 621, Far Hills Br., Dayton 9, Ohio.

May 14-17

Design Engineering Show, Convention Hall, Philadalphia, Pa. For information write Clapp & Poliak, 341 Madison Ave., New York, N. Y.

May 14-17

The Physical Society 40th Exhibition of Scientific Instruments and Apparatus, Royal Horticultural Society's Halls at Westminster. For information write Exhibition Secretary, 1, Lowther Gardens, Prince Consort Rd., London, S.W. 7, England.

May 17-18

7th Annual Conference on Fundamentals, Current Practice and Recent Advances in Industrial Engineering, Shoreham Hotel, Washington, D. C. For information write American Institute of Industrial Engineers, 145 N. High St., Columbus 15, Ohio.

May 14-19

International Colloquim on Spectroscopy, 6th annual meeting to be held at Amsterdam, Netherlands. Persons wishing to attend or contribute should correspond with the Secretary, Colloquim Spectroscopicum Internationale, Laboratorium voor Analytische Chemie, 125 Nieuwe Achtergracht, Amsterdam-C4, Netherlands.

May 16-18

Society for Experimental Stress Analysis, 1956 Spring Meeting, William Penn Hotel, Pittsburgh, Pa. Information: Dr. W. M. Murray, Secy-Treas., P. O. Box 168, Cambridge 38, Mass.

May 21-24

Electronic Parts Distributors Show at the Conrad Hilton Hotel, Chicago, Ill. For information write S. I. Neiman. EPDIN, La Salle St., Chicago 2, Ill.

May 23-25

ASME-EIC Meeting, Mount Royal Hotel, Montreal, Canada.

(*Continued on page* 658)

Solve that design or production problem...fast! with

AUBURN

• GASKETS • PACKINGS
• WASHERS • SEALS • SHIMS
• BUSHINGS • "O" RINGS

86 YEARS OF

AUBURN "KNOW-HOW"

HAS THE ANSWERS!

Yes . . . over 86 years experience in engineering, designing, fabricating and production qualifies Auburn to help you find the ideal answer to your problem. Where gaskets, washers, and other sealing devices are concerned, Auburn engineers are tops in the field. Their know-how is yours—for the asking. We are tooled to fabricate in virtually any material:

Leather • Asbestos • Teflon • Silicone Rubber
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360 Stack St., Middletown, Conn.
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For more information circle **32** on inquiry card.

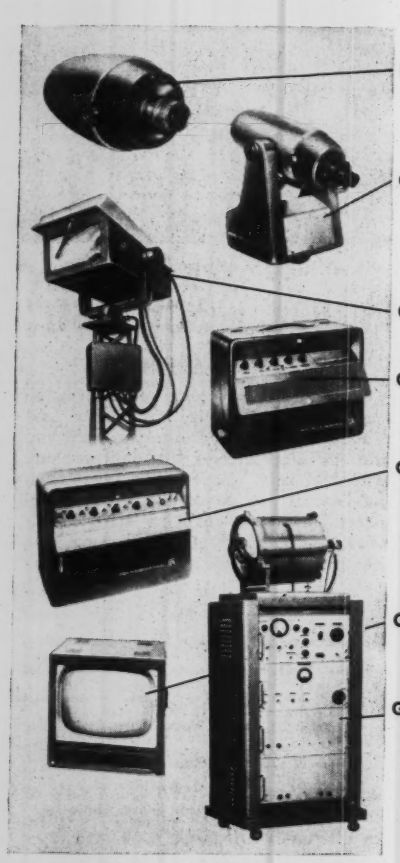
Industrial Uses Widened by *New Features* of GPL *ii-TV*®

Many additional industries are benefited, many established industrial applications made easier, by new closed-circuit equipment which has been added to the GPL *ii-TV** System.

Have you a task that can be simplified by the instantaneous transmission of visual data? Like monitoring an assembly line or a remote machine? Controlling a complicated or dangerous process? Surveillance? Sales training? Stockholder relations? GPL *ii-TV* can help you solve these and hundreds of other business and industrial "seeing" problems.

The new GPL *ii-TV* equipment incorporates the same skilled design, the same top quality material and construction, for which all GPL television equipment is noted. When you use GPL *ii-TV* you are assured of outstanding picture quality, ease of operation and minimum upkeep. Moderate initial cost is often quickly offset by savings the equipment makes for you.

*The *industrial-institutional TV* System manufactured by General Precision Laboratory.



Basic *ii-TV* Camera—smaller than a football, weighs only 5 lbs. Shaped to fit into tight places. No special lighting needed; sensitive Vidicon tube picks up quality pictures at low light levels. Plugs into any AC wall outlet.

GPL *ii-TV* Camera mounted for remote-control, *indoor* use. Changes in direction—horizontal and vertical—adjustment of lens opening and focus can all be made from remote location. Full 360° camera viewing, 90° tilt.

GPL *ii-TV* Camera for remote-control, *outdoor* use. Weatherproof and explosion proof housings; full 360° camera viewing, 90° tilt.

GPL *ii-TV* Control Unit. 26 lbs. including case. Easily carried by one person. Wall or rack-mounted for permanent installation. Can be located remote from camera.

GPL *ii-TV* Switching Unit. Provides push-button selection for viewing the reports of four cameras, using only one camera control unit. With sequencing equipment, automatic remote surveillance of an entire production line or every step in control of a process is possible.

GPL Monitors or ordinary home TV receivers can be used. Circuit can include any number of receivers. Coaxial lines, easy to install, provide unlimited closed-circuit distribution.

GPL TV Projector. Multiplies the usefulness of a closed-circuit TV system by throwing bright, clear, movie-size pictures on a wall screen. Enables several hundred people to watch together.

Find out how GPL *ii-TV*'s built-in superior features can help you. Write:

GPL GENERAL PRECISION LABORATORY
INCORPORATED
PLEASANTVILLE, NEW YORK

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

For more information circle **33** on inquiry card.

For detailed information on

GPL *ii-TV*®

contact any of the following

SALES REPRESENTATIVES

- **Technical Instruments, Inc.**
  971 Main Street
  Waltham 54, Mass.
  Tel: Twinbrook 3-1400
  TERRITORY: Massachusetts, Rhode Island, Connecticut, New Hampshire, Maine, Vermont, Northern New York

- **W. A. Brown & Associates, Inc.**
  3610 Mt. Vernon Avenue
  Alexandria, Virginia
  Tel: Overlook 3-6100 3-6333
  TERRITORY: Florida, Georgia, North Carolina, South Carolina, Maryland, Delaware, Alabama, Mississippi, Tennessee, Virginia, West Virginia

- **M. P. Odell Company**
  2536 Euclid Avenue
  Cleveland 15, Ohio
  Tel: Prospect 1-6171
  TERRITORY: Eastern Michigan, Western Pennsylvania, Ohio

- **Hugh Marsland & Company**
  6405 North California Avenue
  Chicago 45, Illinois
  Tel: Ambassador 2-1555 2-1556
  TERRITORY: Western Michigan, Indiana, Illinois, Iowa, Nebraska, North Dakota, South Dakota, Minnesota, Wisconsin, Kansas, Missouri, Kentucky

- **J. Y. Schoonmaker Company**
  2011 Cedar Springs
  Dallas 1, Texas
  Tel: Sterling 3335
  TERRITORY: Texas, Oklahoma, Louisiana, Arkansas

- **Don H. Burcham Co.**
  P. O. Box 4098
  510 N. W. 19th Avenue
  Portland 9, Oregon
  Tel: Capital 7-3830
  TERRITORY: Washington, Oregon, Montana, Idaho

- **Kittleson Company**
  416 No. La Brea Avenue
  Los Angeles 36, California
  Tel: Webster 8-2455
  TERRITORY: California, Nevada, New Mexico, Arizona

- **Canadian Westinghouse Company, Ltd.**
  P. O. Box 510
  Hamilton, Ontario
  Tel: Jackson 8-3461
  TERRITORY: Canada

or

General Precision Laboratory
Incorporated

- **Main Office**
  (including New York District Office)
  63 Bedford Road
  Pleasantville, New York
  Tel: Pleasantville 2-4100

- **Mid-Atlantic District Office**
  The Benson, Suite 111B
  Jenkintown, Pennsylvania
  Tel. Turner 4-3476

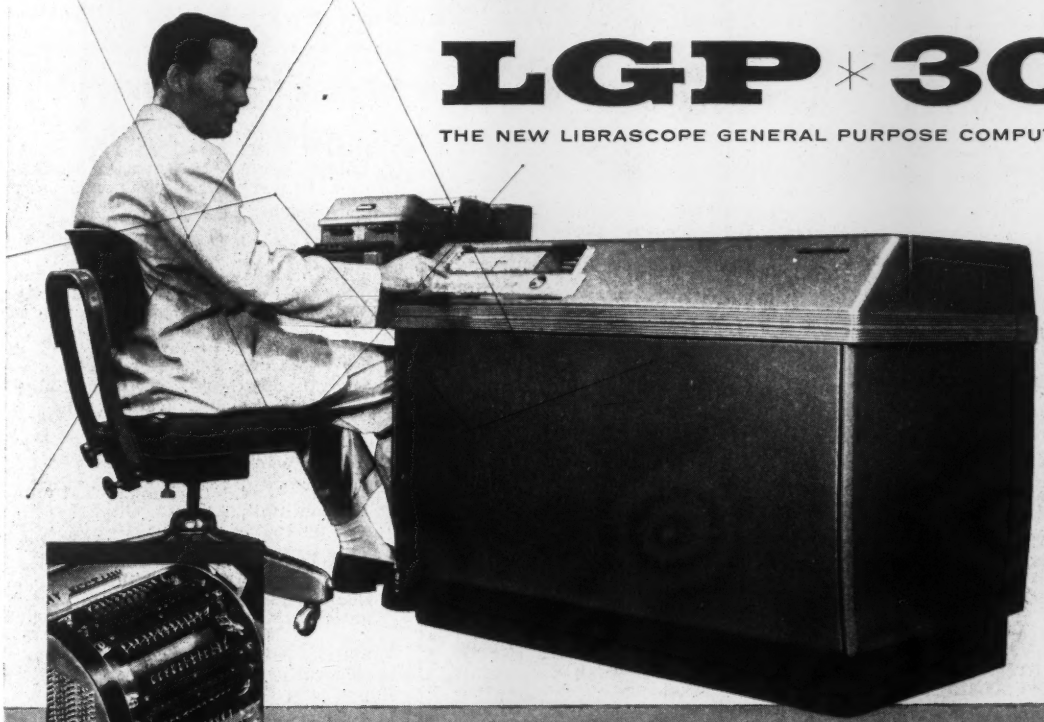
- **Mid-Western Office**
  188 West Randolph Street
  Chicago, Illinois
  Tel: Dearborn 2-6453

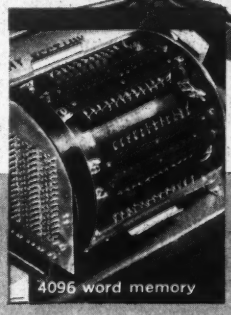
- **Western Office**
  21 N. Santa Anita Avenue
  Pasadena, California
  Tel: Sycamore 5-5869

the new approach to large scale computations in automatic systems design!

LGP*30

THE NEW LIBRASCOPE GENERAL PURPOSE COMPUTER





4096 word memory

SPECIFICATIONS:

Word length:
30 bits, and sign
Mode of Operation:
Serial, one address
Program Storage:
Internal
Access time:
8.5 ms av. 2 ms min.
Transfer time:
1 ms min, 17 ms max.
+ time: .26 ms
÷ × time: 17 ms
Power: 1500 Watts

One word defines the "new approach" of the LGP-30... SIMPLICITY. *Operating Simplicity*... for the average engineer... made possible by the elimination of non-essential commands. Programming techniques are easily mastered. *Design simplicity*... that results in complete mobility. The LGP-30 may be operated from any 115 Volt AC outlet. *Service simplicity*... because fewer components, conservatively operated, mean less "time-out" for maintenance. And, too, the LGP-30 costs considerably less than any other general purpose computer—to buy and operate.

Write for brochure describing applications, operation and detailed specifications.

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE, INC. • 808 WESTERN AVE. • GLENDALE, CALIFORNIA

For more information circle **34** on inquiry card.

KEARFOTT R 900 SERIES SYNCHROS

for immediate delivery

These SYNCHROS are mass produced in a plant devoted exclusively to their manufacture. This makes the following advantages possible:

HIGH ACCURACY
Probable error 7 mins.
Maximum error 10 mins.

HIGH AND LOW TEMPERATURE STABILITY
Rugged construction minimizes null shift with temperature variations.

CORROSION RESISTANCE
Stainless steel housings, shafts, bearings and laminations.

LOW PRICES:

TYPE	MODEL	PRICE*
Transmitter	RS911-1A	$29.50
Control Transformer	RS901-1A	29.50
Repeater	RS921-1A	31.50
Differential	RS941-1A	51.00
Resolver	RS931-1A	44.00

**Based on 1-25 unit price with leads and standard shaft. Quantity prices on request.*

LET US KNOW YOUR DELIVERY REQUIREMENTS — WRITE TODAY

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems and other high accuracy mechanical, electrical and electronic components.

Send for bulletin giving data of components of interest to you.

Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

For more information circle **35** on inquiry card.

EVENTS—CONTINUED

(*Continued from page* 655)

June 6-8
American Society for Quality Control 10th Annual Convention and Exhibit, Palais Du Commerce, Montreal, Canada. For information write Charles R. Kendel, Lamson & Sessions Co., 1971 West 85th St., Cleveland 2, Ohio.

June 11-15
Symposium on Molecular Structure & Spectroscopy, Dept. of Physics & Astronomy, Ohio State University, Columbus 10, Ohio. For information write H. H. Nielsen, Ohio State University.

June 11-29
Process Control Theory (Summer Study Program), Case Institute of Technology. For information write Director of Special Programs, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.

June 14-16
ASME Applied Mechanics Conference, University of Illinois, Urbana, Ill.

June 16-23
5th World Power Conference, Vienna, Austria. For information write Secretary, U. S. National Committee of WPC, Engineers' Joint Council, 33 W. 39th St., New York 18, N. Y., or Secretary, International Executive Council, WPC, 201-2 Grand Bldgs., Trafalgar Square, London, W.C. 2, England.

June 17-22
ASTM Annual Meeting, Chalfonte-Haddon Hall, Atlantic City N. J.

June 17-23
2nd Congress of the International Commission on ACOUSTICS, International Union of Pure and Applied Physics, New York, N.Y. For information write P. Fleury, Secretary General of IUPAP, 3 Boulevard Pasteur, Paris 15e, France.

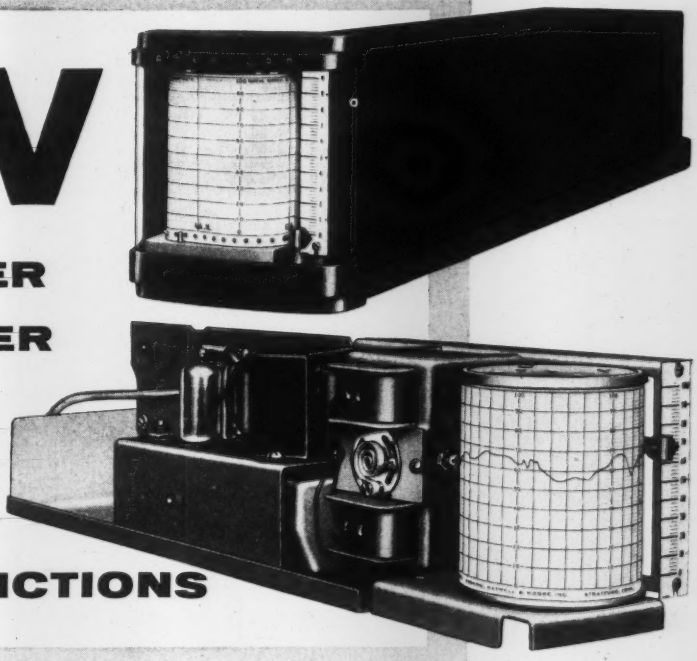
June 18-22
4th Annual Human Engrg, Institute, Dunlap & Associates, Inc., 429 Atlantic St., Stamford, Conn.

June 18-24
"Automation" Meeting and Exhibition. French Association of Electronic Engineers, Paris, France. Please address all correspondence to Secretariat du Colloque sur l'Automatique, Chaire de Mechanique, Conservatoire National des Arts et Metiers, 292 rue Saint-Martin, Paris, (III°) France.

November 26-30
Third International Automation Exposition, New York Trade Show Building, 500 8th Ave., New York, N. Y. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Penna.

NEW

MICROAMMETER
MILLIVOLTMETER
RECORDER
PERFORMS 6
ESSENTIAL FUNCTIONS



★ **Measures low-level dc signals with calibration accuracy within 0.5%, and sensitivity within 0.2% of span.**

★ **Records on 3" continuous strip chart or IBM-type card chart, with linear coordinates.**

★ **Positions recording pen with force many thousand times greater than usual direct-deflection electrical movements.**

★ **Operates on force-balance principle compensating for ambient conditions, changes in power supply and components.**

★ **Gives high-speed recording — up to 0.05 seconds for 63% of fullscale changes.**

★ **Provides span and zero adjustments for ease of calibration and zero suppression in the field, without special equipment.**

The new 'American-Microsen' Series 130 Recorder is a highly sensitive microammeter or millivoltmeter that gives positive, accurate electrical measurement and rugged, maintenance-free service. Yet the unit costs less than other recorders for the same purpose.

Heart of the Series 130 Recorder is the "Microsen" balance that converts low-level dc input signals into powerful output current to drive the recording pen. Pen position is fed back to the input. Consequently, the recording unit is force-balanced in precise relationship with the input signal. Power is ample to operate alarm contacts, which are available.

SPECIFICATIONS

POWER SUPPLY: 115 volts, 60 cycles. **POWER REQUIREMENT:** 9 watts

INPUT RANGES: Voltage – 0-20 millivolts to 0-100 volts dc. **Current** – 0-200 microamperes to 0-100 milliamperes dc. **Input Sensitivity** – 6700 ohms per volt.

ACCURACY: ± 0.5% of span. **SENSITIVITY:** ± 0.2% of span. **REPEATABILITY:** ± 0.25% of span.

EFFECT OF SUPPLY VOLTAGE: Less than 0.5% error 90-130 volts.

EFFECT OF AMBIENT TEMPERATURE: Less than 0.5% error 50° to 100° F., and less than 1% to 130° F.

RESPONSE TIME: Fast Speed – 0.2 seconds standard for 63% of fullscale input change; up to 0.05 seconds for 63% on special order. **Slow Speed** – approximately 4 times fast speed setting.

SHOCK RESISTANCE: Withstands shock up to 30 times gravity.

CHART SPEEDS: Strip Chart – 1" per hr., standard; 3" or 6" per hr. available. **Card Chart** – 1 rotation per day, standard.

SPAN ADJUSTMENT: ± 10% of span. **ZERO ADJUSTMENT:** ± 100% of span.

PRICE: $250.00 consumer net for standard models.

Write for Bulletin MG10

MANNING, MAXWELL & MOORE, INC.

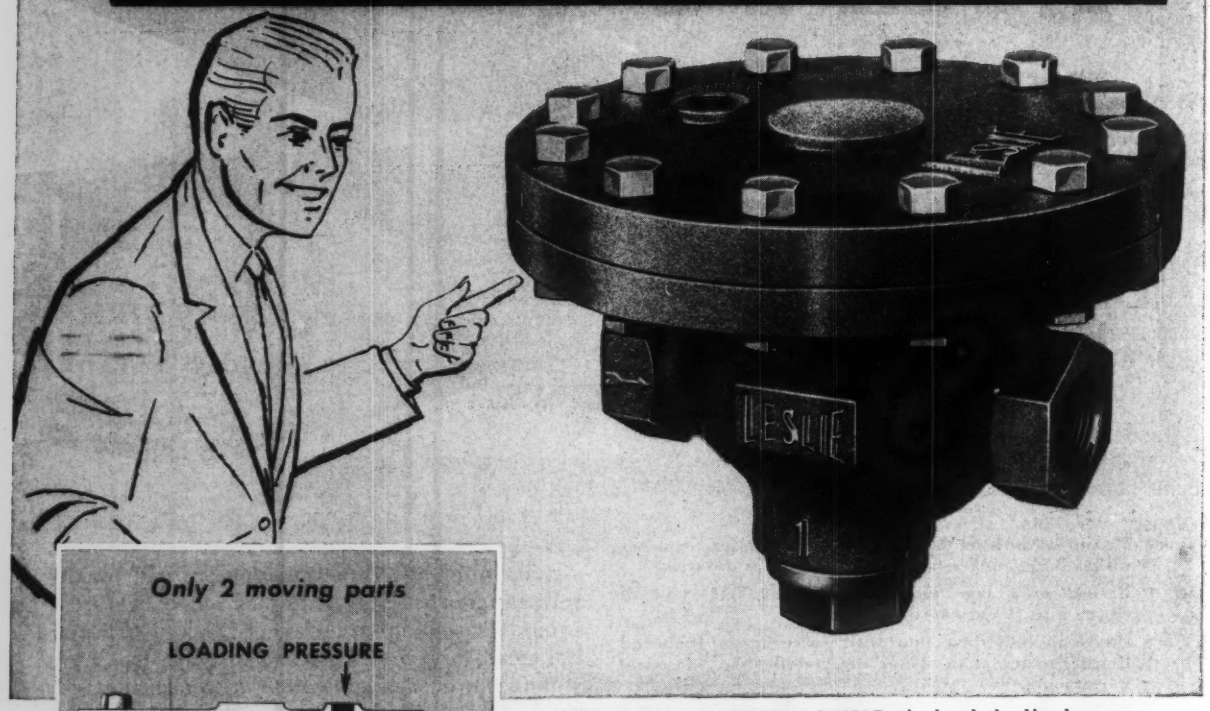
MAXWELL MANNING M&M & MOORE INC. TRADE MARK

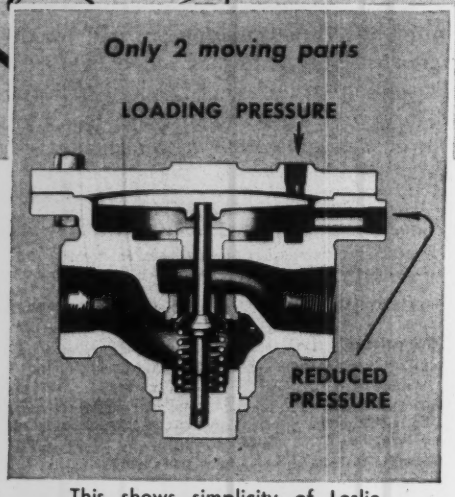
INDUSTRIAL CONTROLS DIVISION, STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC TRANSMITTERS, INDICATORS, RECORDERS, CONTROLLERS, ELECTRO-PNEUMATIC VALVE POSITIONERS AND ELECTRO-HYDRAULIC CONTROL VALVE OPERATORS.

For more information circle **36** on inquiry card.

Now Leslie brings you this New NO MAINTENANCE* Reducing Valve





This shows simplicity of Leslie Class G-1 pressure reducing valve.

HERE IS AN AMAZINGLY SIMPLE air loaded, diaphragm operated, pressure reducing valve that is virtually maintenance-free for steam heat or process steam application.

Only two moving parts and no seals, no stuffing boxes, no small dirt-catching parts — practically nothing can get out of order! And a stainless steel hardened main valve with highly polished finish minimizes wear.

This new Leslie valve instantly feels the effect of any flow change and responds to changes as small as 0.1 psi. It can be adjusted easily from minimum to maximum of reduced pressure range from a remote point, even a thousand or more feet away.

This valve is used in steam process and heating lines. And, its uses are unlimited for any steam reductions within body material limits (250 psi, 450°F).

Ask your Leslie engineer to tell you more about this amazing valve. He's listed in your classified directory under "Valves" or "Regulators".

guaranteed no maintenance for 3 years.

Send for Bulletin 561 today.

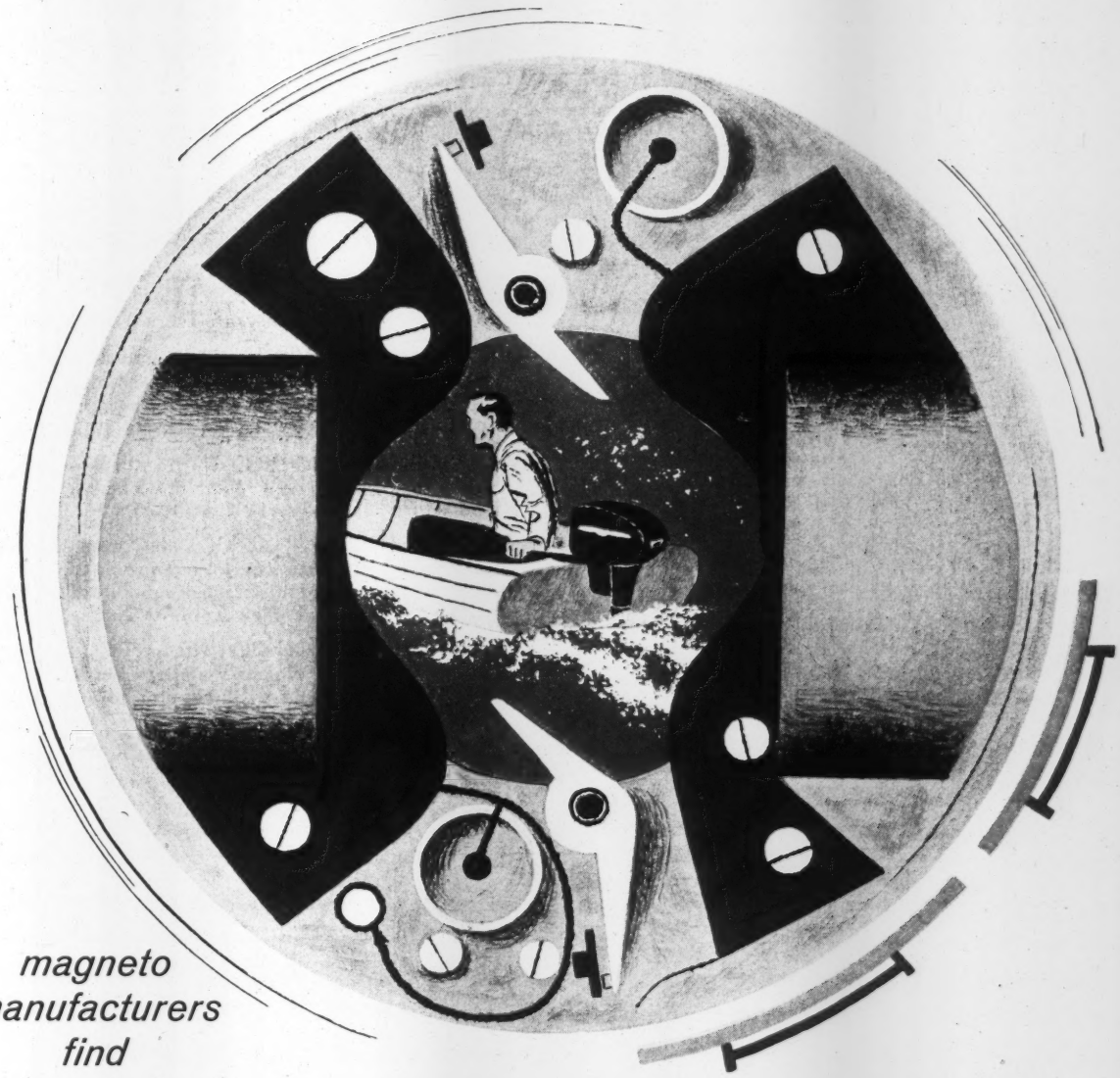
TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

CONTROLLED QUALITY MEANS QUALITY CONTROLS

For more information circle **37** on inquiry card.



magneto manufacturers find

CRUCIBLE PERMANENT MAGNETS

provide maximum energy... minimum size

The *consistently higher* energy product of Crucible Alnico permanent magnets enables manufacturers to use smaller, more powerful magnets in the magnetos of outboard motors, power mowers and other gasoline-powered equipment.

In fact, ever since Alnico alloys were first developed, Crucible has been supplying them to manufacturers of permanent magnet magnetos, generators and motors and all types of magnet-equipped devices.

Pioneers in magnet design and production, Crucible's magnet division is backed by a half-century of fine special steelmaking. So when you have a magnet application it will pay you to call Crucible. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

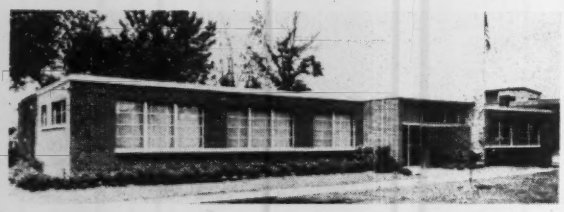
For more information circle **38** on inquiry card.

New Plants and Mergers

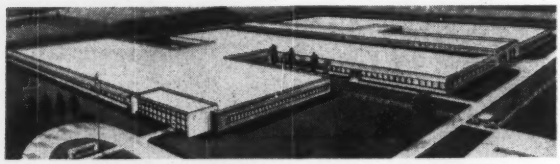
TEXAS INSTRUMENTS INC., Dallas, announces an agreement to purchase the business and assets of the Burlington Instrument Co., Burlington, Iowa. The Burlington instrument line will be added to the purchaser's Component Div.

ARGA DIV., BECKMAN INSTRUMENTS, INC., announces purchase of the inventories of mechanical and electro-mechanical components manufactured by Belock Instrument Corp. of New York.

RICHARDSON SCALE CO., Clifton, N. J., announces completion of their new building No. 6—erected over and around old No. 6 without halting production work.



VICKERS INC., Detroit 32, Mich., announces completion of new 150,000-sq-ft Administrative and Engineering Center.



ASKANIA REGULATOR CO., Chicago, Ill., announces purchase of Heinz Engineering Co., Arlington, Va.

BECKMAN INSTRUMENTS, INC., announces the establishment in the Stanford community of the Shockley Semiconductor Laboratory to develop and produce transistors and other semiconductor devices.

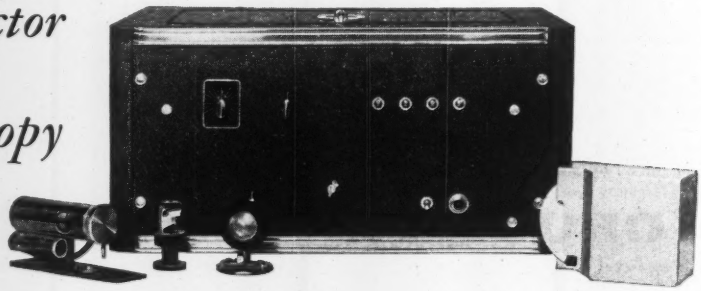
SPRAGUE ELECTRIC CO., North Adams, Mass., announces plans for a new plant at Concord, N. H., to manufacture surface-barrier transistors.

THE FARRAND OPTICAL CO., INC., announces that "Inductosyn" automatic control equipment will hereafter be manufactured and distributed by Farrand Controls, Inc., 4401 Bronx Blvd., New York 70, N. Y.

AUTOMATIC SWITCH CO., Orange, N. J., announces the appointment of Koontz-Wagner Electric Co., Inc., South Bend 1, Indiana as distributor of Asco solenoid valves.

DONNER SCIENTIFIC CO., announces plans for a new plant on a ten-acre site recently purchased in Concord, Calif.

A Superior Detector for Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infrared spectroscopy are:

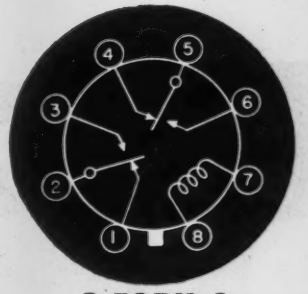
1. An effective sensitive area 3/32" in diameter.
2. Sensitivity of 6 x 10^{-11} watts RMSENI when used with "chopped beam" method and with recording time constant of 1.6 second.
3. Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the micro-wave region.
4. Improved, drift-free, A.C. operated amplifier with step gain controls and four response periods.

Write for EPLAB Bulletin No. 10

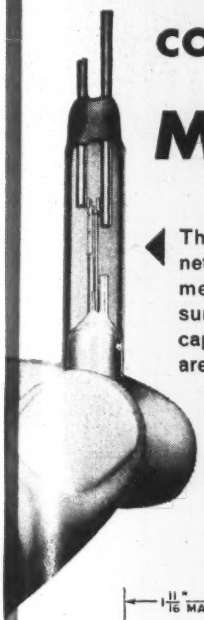
THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
2 SHEFFIELD AVENUE, NEWPORT, RHODE ISLAND, U.S.A.

For more information circle **39** on inquiry card.

3 NEW CLARE MERCURY-WETTED CONTACT RELAYS TO HANDLE MULTIPLE CIRCUITS

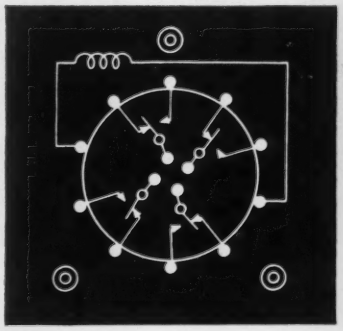


2 FORM C

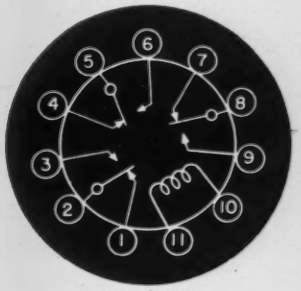


These relays contain 2, 3, or 4 magnetic switches. Each switch is hermetically sealed in a high pressure hydrogen atmosphere in a glass capsule. Platinum contact surfaces are continuously wetted with mercury by capillary connection to mercury reservoir.

TYPICAL BASE CONNECTION DIAGRAMS



4 FORM C



3 FORM C

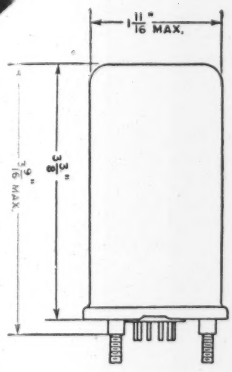


Photo and dimensional drawing of steel can in which 4 Form C switches are enclosed with coil. Plug-in header shown.

SAVE SPACE, MONEY and POWER

In applications requiring more than 1 Form C contact, a multicontact relay may be used instead of 2, 3 or 4 of the standard type HG Mercury-Wetted Contact Relays described in Sales Engineering Bulletin No. 120, thereby saving chassis space, first cost, and operating power.

ELECTRICAL FEATURES

LONG LIFE: Conservative life expectancy of over a billion operations when operated within ratings.

HIGH-SPEED: Give consistent performance at speeds up to 60 operations per second.

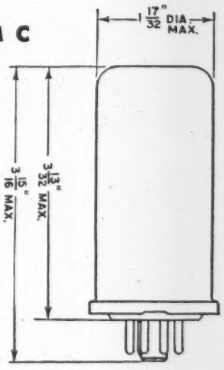
HIGH CURRENT—and voltage-handling capacity, up to 5 amperes, up to 500 volts; (250 volt-amperes, max.)

UNIFORMITY: Operating time varies by only about 0.1 millisecond under constant drive conditions.

NO CONTACT BOUNCE

2 OR 3 FORM C

Photo and dimensional drawing of steel can for either 2 or 3 Form C switches. Octal base plug shown is for 2 Form C. An 11 pin base is standard for 3 Form C. Solder terminals also available.



MECHANICAL FEATURES

- Small chassis space required
- Convenient plug-in mounting
- Environment-free
- Tamperproof
- High sensitivity
- Maintenance-free
- No contact wear
- Adjustment cannot change

FOR COMPLETE INFORMATION

on CLARE Mercury-Wetted Contact Relays for single or multiple circuits contact your nearest CLARE representative or address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.

Send for CLARE Sales Engineering Bulletin No. 120

FIRST in the industrial field

CLARE RELAYS

For more information circle **40** on inquiry card.

New, low cost, versatile

INDUSTRIAL COUNTER

Measures frequency, speed, rpm, rps, random events

Measures weight, pressure, temperature, acceleration*

Direct numerical readings 1 cps to 120 KC

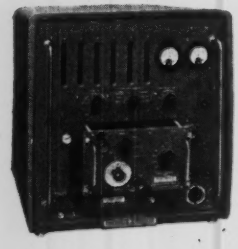
High accuracy, simple operation, compact, rugged

-*hp*- 521A—$475.00

New -*hp*- 521A is designed to be the most useful, accurate low cost industrial counter ever offered. It measures frequency, speed, rpm, rps, and counts random events within a selected time interval. With transducers, it measures weight, pressure, temperature, acceleration and other phenomena which can be converted to frequency. It is direct reading in cps, rpm or rps, and can be used readily by non-technical personnel. Period of count is 0.1 or 1 second; display time can be varied.

The 50/60 cycle power circuit is used as the time base; or, for greater accuracy, a plug-in crystal controlled time base is available at extra cost. There are accessory power supplies of —150 v dc, +300 v dc and 6.3 v ac. Connections are also supplied for photocells and an external 60 cycle standard. Lightweight, compact, sturdy; particularly useful with -*hp*- Optical Tachometer Pickups and Tachometer Generators. -*hp*- 521A, $475.00 (with plug-in crystal time base, $575.00).

Other versatile -*hp*- Counters



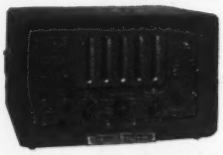
-*hp*- 524B Electronic Counter with 525/526 series Plug-Ins. Revolutionary all-purpose, direct-reading counter. Buy basic counter, plug-ins giving measuring coverage you need now. Later add other inexpensive plug-ins to double, triple counter's usefulness. Basic counter range: Frequency 10 cps to 10 MC, period 0 cps to 10 KC, stability 1/1,000,000. -*hp*- 524B, $2,150.00Δ.

-*hp*- 525A/B Frequency Converters extend 524B's range to 100 or 220 MC, increase video sensitivity. -*hp*- 525A/B, $250.00.

-*hp*- 526A Video Amplifier increases counter's sensitivity to 10 mv, 10 cps to 10 MC. $150.00.

-*hp*- 526B Time Interval Unit permits counter to measure interval 1 μsec to 100 days with accuracy of 0.1 μsec, ±0.001%. $175.00.

-*hp*- 522B Electronic Counter. Compact, moderate price; frequency, period or time measurements. 10 cps to 100 KC. Reads direct in cps, KC, seconds, milliseconds. Automatic count reset, repetitive action. Stability 5/1,000,000, display length variable. Easily used by non-technical personnel. $915.00Δ.



-*hp*- 508A Tachometer Generators. Use with electronic counters, frequency meters to measure directly 15 to 40,000 rpm. Produces 60 cycle output frequency per revolution; (-*hp*- 508B produces 100 cycles) -*hp*- 508A or 508B, $100.00.

-*hp*- 506A Optical Tachometer Pickup. For measuring rotation 300 to 300,000 rpm. Ideal for moving parts of small energy or where mechanical connection is impractical. $100.00.

*Data subject to change without notice. Prices f.o.b. factory. ΔRack mount slightly less. *With transducers.*

Electronic Test Instruments

Quality, value, complete coverage

HEWLETT-PACKARD COMPANY

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PLEASE SEND INFORMATION ON:

____521A ____522B ____524B & Plug-Ins ____506A ____508A/B

Name_____

Company_____

Street_____

City_____ **Zone**____ **State**_____

For more information circle **41** on inquiry card.

PLANTS—CONTINUED

P. R. MALLORY & CO. and **GENERAL DRY BATTERIES, INC.** of Indianapolis and Cleveland, have merged through the acquisition by Mallory of the business of General Dry.

MICRO SWITCH DIV., Minneapolis-Honeywell Regulator Co., announces opening of a new factory near Independence, Iowa.

UNIMAX SWITCH DIV. of the W. L. Maxson Corp. has new enlarged facilities at Wallingford, Conn.

DYNAMICS CORP. OF AMERICA's subsidiary, Reeves Instrument Corp. has taken over a modern $5 million plant and added facilities at Roosevelt Field, Mineola, N. Y.

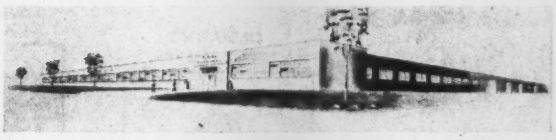
NEW DEPARTURE DIV., General Motors Corp., announces expansion of engineering and manufacturing facilities to include a complete line of miniature ball bearings.

MERIT COIL & TRANSFORMER CORP., Chicago, announces opening of a new warehouse at 312 7 St., San Francisco, Calif.

THE TELEREGISTER CORP., Stamford, Conn., announces the completion of arrangements for obtaining loans totaling $11 million to finance industrial electronic data handling systems and manufacturing operations.

AXEL ELECTRONICS DIV., Axel Brothers, Inc., announces the transfer of administrative, laboratory and production facilities to a modern five-story plant at 134 Jamaica Ave., Jamaica 18, N. Y.

SUN ELECTRIC CORP., Chicago, Ill., announces the start of construction on a new $1-million Engineering Research and Development Center in Wheeling, Ill.



THE MAGNAVOX CO., Fort Wayne, Indiana, announces purchase of assets, properties and goodwill of the Sentinel Radio Corp., Evanston, Ill.

THE DOW CHEMICAL CO., Midland, Mich., announces opening of new $1.1 million laboratory building for research in biochemistry.

CARTER MOTOR CO., Chicago, announces a new main plant, now under construction, that will feature air-conditioned and sound-proofed testing laboratories and inspection department.

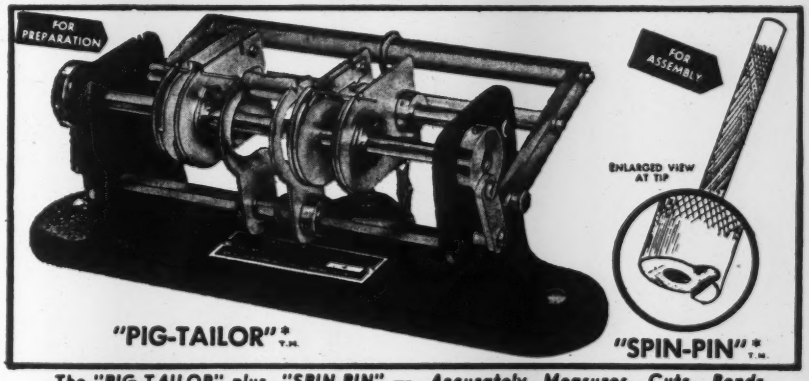
NUCLEAR CORP. OF AMERICA, INC., announces acquisition of the assets and business of Central Sales & Mfg. Corp. of Denville, N. J.

THE REDMOND CO., INC., Angola, Indiana, announces that their new plant, designed specifically to produce their new "Type AL-4" motor, will be in full operation about May 1.

ROGER WHITE ELECTRON DEVICES, INC., announces the acquisition of a new plant in Haskell, N. J., that will triple production facilities for microwave equipment.

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

* PATENT PENDING

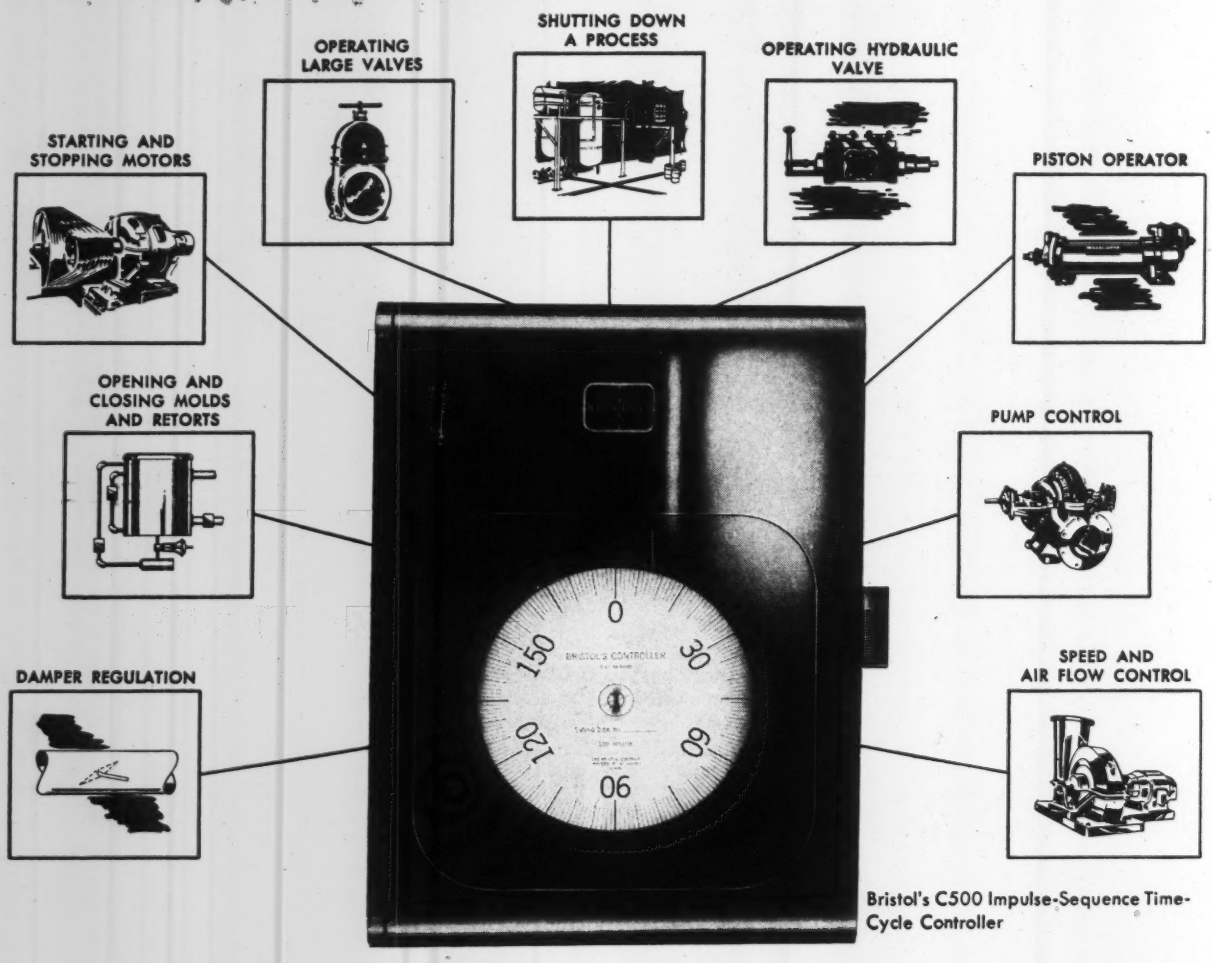
Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. IA3-P

BRUNO-NEW YORK INDUSTRIES CORPORATION

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

460 WEST 34th STREET • NEW YORK 1, N. Y.

WHAT'S NEWS AT BRISTOL . . .



Bristol's C500 Impulse-Sequence Time-Cycle Controller

AUTOMATIC TIMING . . . THE KEY TO AUTOMATION

In almost every plant you'll see operations that *must* be carried out according to definitely timed sequences.

Experience has shown that such operations can be controlled with greater precision by automatic time-cycle controllers than by any other method—and when accurate timing is *continuously* maintained, here are the happy results:

- production from given installed equipment is increased
- uniformity of product is assured
- rejections are almost wholly eliminated
- operators are released for other important duties

Automatic control also puts the process under direct measurement—which means that operating conditions are more easily determinable and more easily reproduced.

Which controller should you select? Hundreds of leading industrial firms, many of them Bristol customers for over 66 years, are using Bristol Automatic Process-Timing Controllers. Our engineers have had long experience in the application of Automatic Process-Timing Controls in practically every industry. They're ready to work on your problem now. Write today for our Bulletin C305. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 6.20

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **43** on inquiry card.

People IN THE NEWS

WESTON ELECTRICAL INST. CORP.—*Earl R. Mellen*, president, announces appointment of *Samuel J. Childs* as vice president and general manager.

BECKMAN—*Dr. Arnold O. Beckman*, president, announces appointment of *Dr. William Shockley* (inventor of the junction transistor) as director of the newly-formed Shockley Semiconductor Laboratory, which will be housed in Spinco's new research and development center now under construction in the Stanford Industrial Tract.

W. Shockley
Beckman Inst.

M. M. Watkins
Walworth Co.

WALWORTH CO.—*Fred W. Belz*, president, announces election of *M. Mark Watkins*, executive vice president and director, Conoflow Corp., to the board of directors of the Walworth Co.; and *M. Mark Watson* as a director.

WALTER KIDDE NUCLEAR LABS., INC., Garden City, N. Y., announces election of *Wilbur E. Kelley* as president.

NORDEN-KETAY CORP.—*Paul W. Adams*, chairman of the board, announces election of *Dr. Louis Ten Eyck Thompson* as vice-president for research.

THE HAYS CORP., Michigan City, Ind.—*Phil Sprague, Jr.*, executive vice president, announces appointment of *Frederick M. Rutledge* as chief control engineer, and *Crayton H. Schwestka* as chief design engineer.

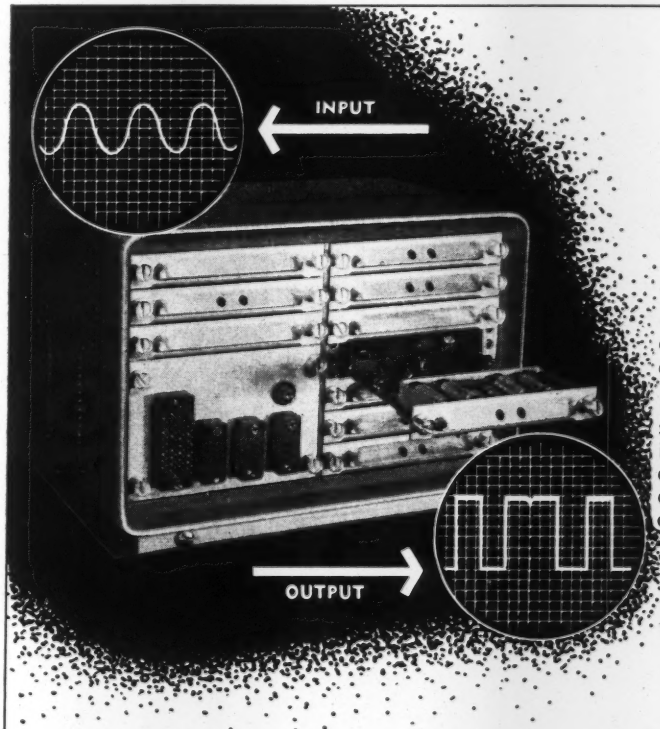
MINNEAPOLIS-HONEYWELL REGULATOR CO. announces the appointment of *Clarence W. Spangle* as general manager of Honeywell G.m.b.H.—company's German subsidiary with headquarters in Frankfurt.

ALLEN B. DU MONT LABORATORIES, INC., Clifton, N. J.—*Ernest A. Marx*, director, International Div., announces appointment of *James Segre*, Milan, as European representative.

CLAUD S. GORDON CO., Chicago, Ill., announces election of *Raymond E. Thompson* as assistant to the president and member of the board.

CONSOLIDATED ELECTRODYNAMICS CORP., TRANSDUCER DIV., Pasadena.—*Kennett W. Patrick*, director, announces appointment of *Robert R. Mawson* as project chief for special electronic pressure-sensing equipment.

GENERAL PRECISION LABORATORY INC., Pleasantville, N. Y., announces the appointment of *S. L. Thomas* as sales manager, and *H. L. Ryder* and *E. K. Price* as



ADVANCED
DIGITAL ENCODER

This encoder is an all electronic piece of equipment capable of digitizing 24,000 8-bit binary code groups per second.

The Coder's all electronic circuitry which includes solid state components mounted on etched circuit, plug-in, cards provides for increased operational reliability and ease of maintenance.

Its compact construction and light weight substantially reduces the need for bulky equipment in data handling systems. Operating at 400 cycles [or 60 cycles with modifications] this equipment affords the capability of use in either air or ground systems.

Among the more salient features are:

Power Requirements: 100 watts
Signal Input Impedance: 100 K ohms
Operating Temperature Range: -55°C to + 71°C
Output Impedance: 1 K ohms
Overall Size: 6-13/16" H x 9-9/16" W x 6-¾" D
Weight: 8 pounds

Personnel Inquiries Invited

RADIATION Inc. Melbourne, Fla. Orlando, Fla.
Electronics • Avionics • Instrumentation

For more information circle **44** on inquiry card.

PEOPLE—CONTINUED

sales engineers for the New York district. Also *William J. Tull* as director of the newly formed Avionic Sales Div., *Walter Cooper* as associate director and manager of the Government Contracts Dept., and *A. C. Haemer* as associate director responsible for airborne sales and service activities.

FULTON SYLPHON DIV., Robertshaw-Fulton Controls Co., Knoxville, Tenn.—*F. G. Cross*, general manager, announces appointment of *George L. Ogdin, Jr.*, as general sales manager.

G. L. Ogdin
Fulton-Sylphon

H. G. Cutright
Amer. Machine

AMERICAN MACHINE & FOUNDRY CO., New York, N. Y.—*Morehead Patterson*, board chairman and president, announces appointment of *Harold G. Cutright* as director of sales of AMF's General Products Group.

DAYSTROM, INC., Elizabeth, N. J.—*Thomas Roy Jones*, president, announces the election of *Walter W. Slocum* as vice president in charge of operations, and *George J. Parker* as vice president in charge of the Washington office.

CARBOLOY DEPT., General Electric Co., Detroit, announces the appointment of *Robert J. Mason* as manager of the Atlantic district, headquarters Newark, and *Howard W. Arnold* as manager of distributor sales.

MARION ELECTRICAL INSTRUMENT CO.—*Roscoe A. Ammon*, president, announces appointment of *Edward S. Maury* as general sales manager.

E. S. Maury
Marion

John Schuch
Jarrell-Ash

JARRELL-ASH CO., Newtonville, Mass., announces appointment of *John Schuch* as general sales manager. New sales representatives are: *Gene Roberts*, Atlanta; *Robert Alvord*, Muskegon; and *Arthur Edwards*, Chicago.

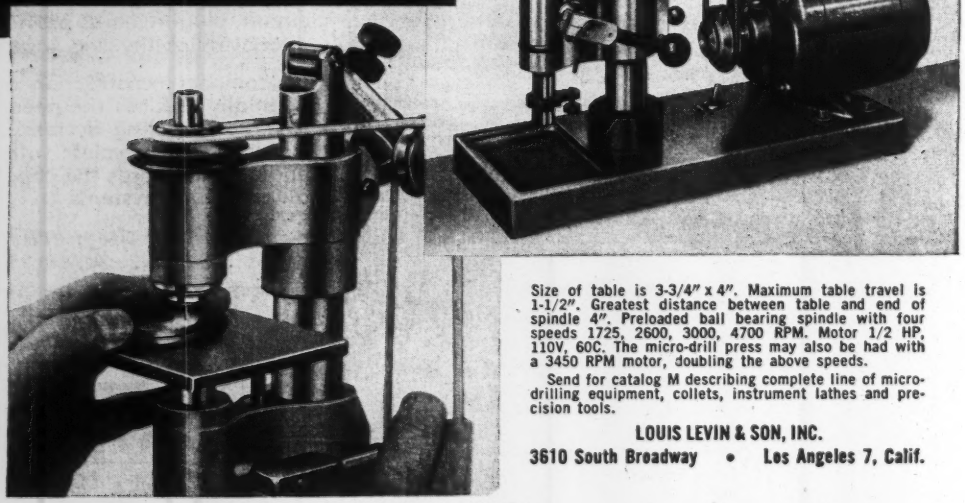
KELLOGG SWITCHBOARD & SUPPLY CO., Chicago, Ill.—*W. P. Hollis*, sales manager, announces appointment of *R. H. Williamson* as manager of the industrial sales department.

HYCOR CO., INC., North Hollywood, Calif., announces appointment of *Philip R. Geffe* as engineering director.

DIAMOND POWER SPECIALTY CORP., Lancaster, Ohio, announces appointment of *John A. Rado* as chief engineer of the Electronics Dept.

EQUIPMENT DIV., NATIONAL RESEARCH CORP., Newton Hihglands, Mass.—*S. Sydney Minault*, general manager, announces appointment of *Ralph H. Vacca* as

SMALL DRILLS MUST BE HELD
IN PRECISION COLLETS TO ASSURE ACCURACY
LEVIN® MICRO-DRILL PRESS
FOR VERY SMALL HOLES
DOWN TO .002"



In the LEVIN micro-drill press drills are held in precision collets. Runout is reduced to practically zero and drill breakage from this cause is eliminated. Collets are available in a complete range of sizes down to .1 mm (.004").

Size of table is 3-3/4" x 4". Maximum table travel is 1-1/2". Greatest distance between table and end of spindle 4". Preloaded ball bearing spindle with four speeds 1725, 2600, 3000, 4700 RPM. Motor 1/2 HP, 110V, 60C. The micro-drill press may also be had with a 3450 RPM motor, doubling the above speeds.

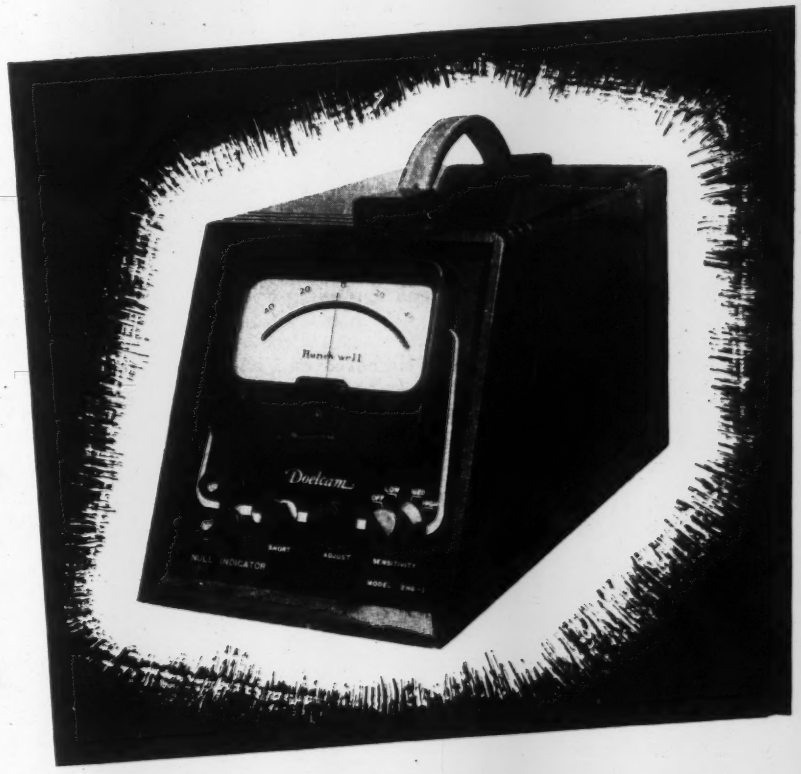
Send for catalog M describing complete line of micro-drilling equipment, collets, instrument lathes and precision tools.

LOUIS LEVIN & SON, INC.
3610 South Broadway • Los Angeles 7, Calif.

For more information circle 45 on inquiry card.

CAN YOU MEASURE NOTHING ACCURATELY?

Now Doelcam Magnetik Null Indicator



EXCLUSIVE FEATURES

- **High Sensitivity**
- **Linear Deflection**
- **Magnetic Converter**
- **Isolated Input**
- **Low Noise Level**

Write for Bulletin NI-4

THE DOELCAM Magnetik Null Indicator, Model 2HG-1, is *both* a null balance detector and a linear deflection indicator. It may be used as either a low level laboratory instrument where *accurate null* measurement is important, or as a fast measuring production test instrument where *linear* off-balance readings and ability to withstand rough usage are essential. All around improved performance is achieved by use of the unique DOELCAM Second-Harmonic Magnetic Converter as the input modulator.

CHARACTERISTICS

HIGH SENSITIVITY: 2 Microvolts per division. 0.003 Microamperes per division.

PROPORTIONAL DEFLECTION: Linearity over full scale range is within 5% accuracy.

ISOLATED INPUT: Input terminals are isolated from chassis and circuit ground.

LOW NOISE LEVEL: Less than 2 microvolts equivalent input. Insensitive to 60 or 120 cycle pickup.

EXCELLENT STABILITY: Zero drift less than 1 division per hour.

INDEPENDENT OF LINE VOLTAGE: No observable drift or change in sensitivity for line variations from 105 to 125 volts.

QUICK READING: Time constant of less than 1 second.

RUGGED: Not damaged by overrange of 1.5 volts d-c.

POLARITY SENSITIVE: Zero-center mirror-scale meter for polarity sensing measurements.

LOW MAINTENANCE: Only one vacuum tube. No moving parts except meter.

Doelcam

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H HONEYWELL

SOLDIERS FIELD ROAD
BOSTON 35, MASS.

Instruments for Measurement and Control

Synchros • Gyros • Amplifiers • Microsyns • Servo Motors

For more information circle **46** on inquiry card.

PEOPLE—CONTINUED

manager of Electronics Development Section, and *H. A. Steinherz* as manager of Mechanical Development Section.

THE BRISTOL CO., Waterbury, Conn.—*H. E. Beane*, vice president-sales, announces appointment of *W. C. Van Leuven* as midwest regional sales manager of the Socket Screw Div.

W. C. Van Leuvin
Bristol Co.

J. M. Klaasse
American Inst.

AMERICAN INSTRUMENT CO., INC., Silver Spring, Md., announces appointment of *James M. Klaasse* as chief engineer.

KOLLSMAN INSTRUMENT CORP., Elmhurst, N. Y.—*Alan G. Binnie*, vice president and assistant general manager, announces appointment of *Joseph J. Langford* as manager of Air Force contracts.

CDC CONTROL SERVICES, INC., Hatboro, Pa., announces the following appointments: *J. Lawrence Tecosky* to vice president and contract manager; *Jack C. Boonshaft* to consulting mechanical development engineer; *Caldwell Jones* to contract engineer; *David P. Goodwin* to electronic development engineer; and *Alfred Krieg* to procurement engineer.

FAIRCHILD CAMERA AND INSTRUMENT CORP. announces appointments: *Russell H. Lasche* as general manager, and *S. R. Viejo* as assistant general manager of the Industrial Camera Div.; *Albert A. Budde* as sales manager of the Components Div.; and *Leonard S. Hermelin* as executive assistant to the general manager of the Reconnaissance Systems Div.

LEEDS & NORTHRUP CO. announces the appointments of *Thomas C. Bennett* as technical assistant for resale at Philadelphia; *Edwin A. Yeo* as manager, Chicago office; *Willard H. Neu* as manager, Pittsburgh office; and *Manley S. Nolen* as manager, Cincinnati office.

ELECTRONIC COMPUTER DIV., CLARY CORP. announces appointments of *John Donan* as supervisor, *Chris A. Christoff* as engineer in charge of mechanical development, and *Ralph Powell* as engineer in charge of electronic development.

D. P. BUSHNELL & CO. announces appointment of *Lewis C. Gust* as technical director.

NRC EQUIPMENT CORP., Newton Highlands, Mass.—*Walter G. Overacker*, sales manager, announces the appointment of *Peter V. Schwab* as Pittsburgh district manager.

STANFORD RESEARCH INSTITUTE, Menlo Park, Calif., announces that *Dr. Frederick E. Terman*, dean of the School of Engineering and provost of Stanford University, has joined the board of directors of Stanford Research Institute as a member and vice-chairman.

NATIONAL COMPANY, INC., Malden, announces election of *Herbert C. Guterman* to chairman of the board.

THIRD INTERNATIONAL AUTOMATION EXPOSITION

November 26 to 30, 1956
New York Trade Show Building

This year's "show of the future" again includes:

- Electronic Computer Clinic, *and*
- Automatic Conveyor Clinic

Write for exhibit and clinic information, and for free tickets to the Exposition, to:
Third International Automation Exposition
Richard Rimbach Associates, Management
845 Ridge Avenue, Pittsburgh 12, Pa., U.S.A.

For more information circle **91** on inquiry card.

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ALNOR PORTABLE PYROMETERS

Wherever heat measurement is a problem—in the laboratory, shop, or in the field—you'll find the completely self-contained, portable Alnor Pyrometer the economical answer. Product of skilled, specialized instrument craftsmen, an Alnor will provide the consistent accuracy for all jobs—and at a cost of less than $100.00.

Get your copy of Bulletin 4434 now! Send this ad on your letterhead to: Illinois Testing Laboratories, Inc. Room 518, 420 No. La Salle Street, Chicago 10, Illinois.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **47** on inquiry card.

10 YEARS

of production service to

THE AIRCRAFT AND MISSILE INDUSTRY!

Initiating production at the dawn of a new era of high speed, high altitude flight, G. M. Giannini & Co., Inc., has steadily progressed to become the largest manufacturer of telemetering and control instruments in the country.

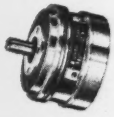
Today, virtually all operational military aircraft use one or more of the 30,000 instruments produced annually by Giannini—instruments which have earned an enviable reputation for high accuracy and consistent reliability.

Young in years, old in experience, Giannini, entering its second decade of operations, offers to its customers the accrued benefits of greatly increased facilities and accumulated engineering and manufacturing skills developed through ten progressively successful years of service to the aircraft and missile industry.

Engineering positions are open at several Giannini locations for career-minded young men—write for details.

Airborne Systems

Digital Data Recording Systems



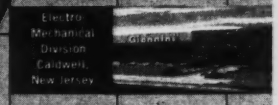
Switching Commutators

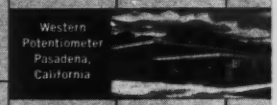
Custom Precision Potentiometers

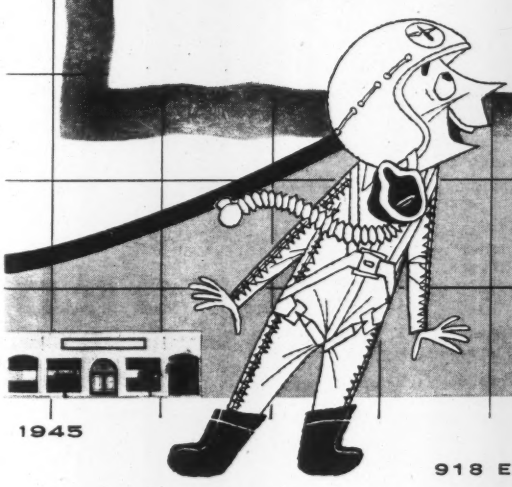
Pressure Transducers

Gyro Instruments

Accelerometers







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G. M. GIANNINI & CO., INC.

918 EAST GREEN STREET • PASADENA, CALIFORNIA

For more information circle **48** on inquiry card.

PEOPLE—CONTINUED

SERVOMECHANISMS, INC. announces the appointment of *Ira L. Kasindorf* as Chief Development Engineer of the Eastern Components Division.

I. L. Kasindorf
Servomechanisms

D. J. Fraade
CEC

C. Bueltman
Permutit

CONSOLIDATED ELECTRODYNAMICS CORP., Pasadena, Calif.—*Joseph F. Davidson,* director of sales, announces the appointment of *David J. Fraade* as a sales specialist in process-control instrumentation.

THE PERMUTIT CO., New York, announces appointment of *Charles Bueltman* as manager, Industrial Waste Treatment Dept.

PACIFIC SCIENTIFIC CO., Los Angeles, Calif.—*Decker G. McAllister,* president, announces election of *Tom Dewar,* manager, Seattle office, to company's board of directors.

MID-CENTURY INSTRUMATIC CORP., New York, N. Y.—*Strain Sutton,* sales manager, announces appointment of *James Edwards* as director of the new Cleveland sales office.

GENERAL RADIO CO., Cambridge, Mass., announces election of *Charles C. Carey* as president.

CHEMPUMP CORP., Phila., Pa.—*D. P. Litzenberg,* vice president, announces appointment of *William W. Drake* as director of newly formed Market Development Dept.

POLARAD ELECTRONICS CORP., Long Island City, N. Y.—*Dr. D. L. Jaffe,* president, announces election of *Frank J. Skwarek* as vice-president.

TEMCO AIRCRAFT CORP., Dallas, Texas, announces appointment of *Martin E. Collis, Jr.,* as group engineer, and *Thomas L. Norton* as assistant plant mgr, Garland, Texas.

VARIAN ASSOCIATES, Palo Alto, Calif.—*Emmett G. Cameron,* production vice president, announces appointment of *Howard R. Patterson* as manager of the Production Engineering Dept., and *B. C. Gardner* as head of the Product Engineering Div.

COOK RESEARCH LABS., Cook Electric Co., Chicago, Ill.—*Dr. J. R. Downing,* director of research, announces the appointment of *Raymond O. Fredette* as assistant director of research.

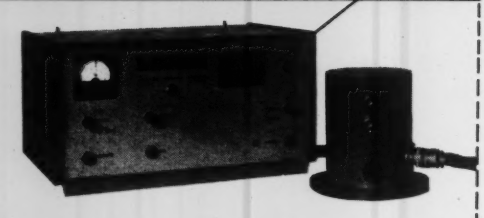
BENDIX AVIATION CORP.—*Edward F. Kolar,* general manager, Red Bank division, announces the appointment of *Dr. Wallace C. Caldwell* to head a new dept. for research and production of transistors.

PACIFIC SCIENTIFIC CO.—*Decker G. McAllister,* president, announces the appointment of *Arnold Carlin* as a sales engineer.

NORTH AMERICAN AVIATION, INC., Los Angeles, Calif., announces the appointment of *Dr. D. B. Duncan* as assistant chief of the Guidance Section of Autonetics.

For precision pressure measurement

CEC's 37-103 Electromanometer



For speed *and* accuracy in pressure measurements, investigate CEC's 37-103 Electromanometer. It equals manometer-tube accuracy (0.05% of full scale)... eliminates interpolation errors by reading out in *direct* numerical form. For complete details on this rugged industrial tool, send today for Bulletin CEC 1547-X16.

CHECK THESE FEATURES...

- fast response (4 sec. full-scale)
- rugged, compact, portable
- two readouts: visual digital and electrical analog (10 volts f.s.)
- negligible temperature effect
- remote operation
- maintenance-free
- interchangeable pressure heads in 5, 15, 60 and 150 psi ranges for gage, differential, or absolute pressures

ALSO AVAILABLE

- special, high-speed system with extra-high resolution. Response time of 0.1 sec. full-scale.

Consolidated Electrodynamics
CORPORATION
formerly Consolidated Engineering Corporation
ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL
300 North Sierra Madre Villa, Pasadena, California

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Thomas A. Edison Inc.'s

PERSONAL DEMONSTRATION

shows how you can

INCREASE PLANT PRODUCTION

Our representatives throughout the nation are ready to demonstrate *a complete* Omniguard system right at your plant or office.

Takes Only a Few Minutes to Prove Simple Omniguard System Protects Bearings and Processes; Cuts Down Time; Increases Equipment Life

Just take a few minutes to prove to yourself how Omniguard can make it possible for you to operate your equipment at peak production rates without fear of breakdowns . . . how this simple temperature detection system gives you ample opportunity to prevent bearing failures or to keep process temperatures within limits.

RECORDS REVEAL FAILURES COSTLY

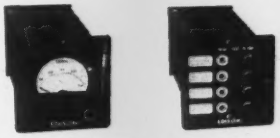
Many operators—after a record check—are astonished to find how much bearing breakdowns have been costing them in maintenance and lost production. They see that the cost is often many times the expense of installing Omniguard.

COMPLETE 4-POINT SYSTEM FOR LESS THAN $500

Consider the thousands of dollars involved in equipment and production output. Contrast this with the fact that one Omniguard unit costs less than $500. And because of its simplicity, installation costs are also low.

SIMPLE, DEPENDABLE

Omniguard has no electronic or moving parts. It is the most dependable system available today. Modular in design, each unit gives you four-point detection. You can add as many as you need . . . as you need them.



The modular indicator and monitor, with their mounting brackets, and the resistance temperature detectors, are all you need for a continuous operating analysis of remote process or bearing temperatures.

Resistance Temperature Detectors

These are just four of the many different types of temperature detectors produced for varied applications of the Omniguard system.

The 242P for high temperatures (to 1300°F.)

The 166NC with pre-loaded sensitive tip specially designed for bearing protection.

The 230N for general purpose industrial use (stem-sensitive).

The 235N90-35 for fast response in corrosive service.

A Partial List of Present Users

American Blower Corp.
City of Chicago
Combustion Engineering, Inc.
DeLaval Steam Turbine Co.
Eastman Kodak Co.
Esso Standard Oil Co.
Florida Power & Light Co.
General Electric Co.
Hercules Chemical Co., Inc.
I-T-E Circuit Breaker Co.
North American Aviation, Inc.
Public Service Electric & Gas Co.
Republic Steel Corporation
Sun Oil Company
Union Carbide & Carbon Corp.
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For more information circle **51** on inquiry card.

BRUSH *...complete systems for noise or vibration measurement*

21 seconds to make complete noise or vibration analysis!

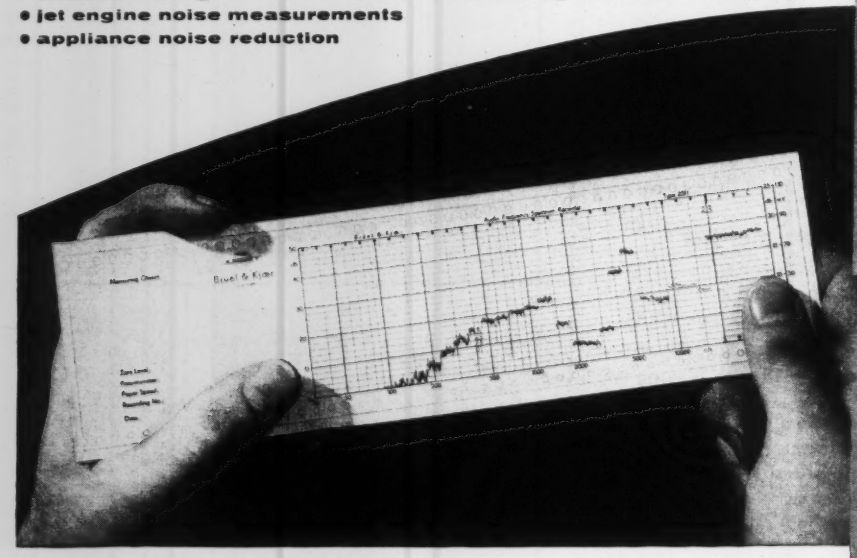
This chart record produced by the Brush Spectrum Recorder presents a complete frequency and noise level analysis for an electric motor. It is an example of the way Brush instrumentation can aid *your* analysis of noise or vibration:

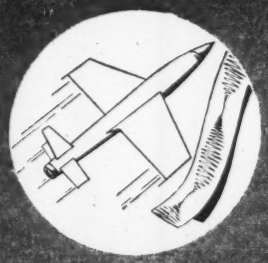
- **All sounds from 14 cycles to 36,000 cycles per second automatically scanned and recorded by the Brush Spectrum Recorder to eliminate laborious plotting of data.**
- **Measurements made in one-third octave steps, to positively identify frequencies.**
- **Complete recording through the complete frequency range made in 21 seconds, to save valuable engineering time.**

The Spectrum Recorder is one unit in the most complete line of noise and vibration instrumentation available (manufactured in Denmark by Bruel & Kjaer). Thus Brush can offer you matched systems, and offer application assistance on complete projects. For complete information call your Brush representative, or write Brush Electronics Company, Dept. **A-4**, 3405 Perkins Avenue, Cleveland 14, Ohio.

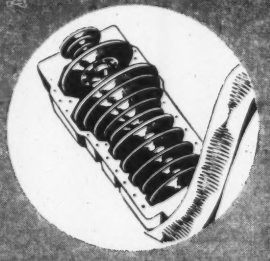
How leading companies use this Brush instrumentation

- engine vibration analysis
- aircraft noise reduction
- accelerometer calibration
- missile testing
- jet engine noise measurements
- appliance noise reduction
- automotive vibration analysis
- tape recorder readout
- plant noise studies
- evaluating acoustic materials

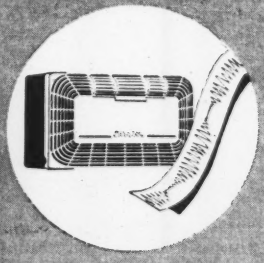




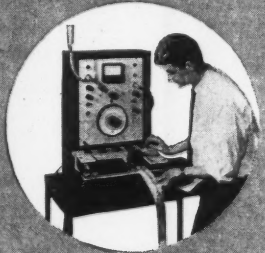
LOCKHEED . . . uses Spectrum Analyzer for data reduction of telemetered information . . . and to measure noise transmission through aircraft fuselage wall panels.



GENERAL ELECTRIC . . . uses Frequency Response Recorder to check mechanical resonance points of both steam and jet turbines when blades are magnetically vibrated.



CARRIER . . . uses Spectrum Recorder for production quality control checks of room air conditioning units.



SPECTRUM RECORDER is integrated system for noise and vibration recording in one-third octave steps.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH ELECTRONICS

Division of Clevite Corporation

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INSTRUMENTS and AUTOMATION

Biographies of significance

SIGNIFICANCE

Edward A. Roberts is a typical example of the instrument specialist in the research organization—fitting into the pattern we have outlined in terms of Charles Lucks of Battelle, Clarence Glassbrook of Stanford Research, and Axel Peterson of Mellon Institute. His biographical data reveal the background and experience required of such key men, their functions, their growth, and their present key position within the over-all field of Instrumentation. This month we are pleased to acknowledge the contributions made to our field by Ed Roberts of Armour Research Foundation.

EDWARD A. ROBERTS

Edward A. Roberts first became interested in electricity while in high school. He obtained an amateur radio license during that period, and a considerable portion of his spare time was spent in the design, construction, and operation of transmitters, receivers, and other electronic equipment.

Now assistant manager of the electrical engineering research department at Armour Research Foundation of Illinois Institute of Technology, Ed began his engineering studies in evening college at Lewis Institute, predecessor of Illinois Tech. At the same time, he completed a tool and die makers' apprenticeship. A graduate of Illinois Tech, he received his MS degree in electrical engineering at IIT in 1948.

In 1943, Ed was employed as an electronics engineer at the Naval Research Laboratory, Washington, D. C., where he participated in radar and countermeasures development work.

For three years during World War II, he served as a naval electronics officer. He completed the radar specialist course at Massachusetts Institute of Technology, received letters of commendation from the Navy for development of simulation equipment for use in electronic navigation and for his participation in atomic weapon tests.

His experience as an instructor includes training of naval officers and electronic technicians in the operation and maintenance of electronic equipment, and as a teaching assistant at Illinois Tech while pursuing graduate studies. This now helps Ed in his "educational" work at ACF.

In 1947, Ed joined Armour Research Foundation where he carried out a number of instrumentation, communications, and radar projects. He was appointed supervisor of the Instrumentation Section of the Electrical Engineering Research department in 1951, directing work on chemical, mechanical, medical, and meteorological instrumentation projects, as well as development of magnetic recording equipment and electronic measurement systems.

He was promoted to assistant manager of the department in June 1955. In this capacity, he heads the instrumentation and computer development activities. More than 20 projects for industry and government are presently in progress under his direction.

When asked to outline his basic instrumentation activities, Ed replied, "Our instrumentation activities are constantly expanding into new areas, with heavy emphasis on magnetic recording and automation. We are now developing special-purpose computers, data storage and processing systems as well as a variety of inspection and process control systems.

(*Continued on page* 677)

more lives than a cat!
Quality Construction —manufactured with extreme care
Designed—with fresh, new ideas —manufactured with the newest, money-saving production techniques
AEMCO
RELAYS
are standouts for performance
... built to last!

One of today's most versatile relay lines, AEMCO relays are "first choice" for more than 100 of the top names in American industry. Design and construction is tops—for only the finest materials are used in AEMCO relays. Specify AEMCO and you're making your best relay buy. You'll profit by the newest production techniques that speed up delivery and save you money. You'll appreciate the prompt delivery on prototypes, the fast tool up for production. You'll find, too, that an AEMCO relay has more lives than a cat and is built to take it! Actually tested on the job, AEMCO relays are dependable and reliable . . . standouts for performance.

AEMCO relays are available in a wide variety of spring and coil combinations, operating potentials and contact ratings. Types include: Open, can, plug-in base, hermetically sealed, midgets, dual-purpose, delayed make or break, circuit control, current and potential relays. Should one of the hundreds of AEMCO relay types fail to meet your exact requirements, we will be happy to design and build a unit to meet or exceed your specifications.

WRITE TODAY

For more information on the standard AEMCO relay line, write for your free descriptive bulletin today!

AEMCO

AUTOMATIC ELECTRIC MFG. CO.

53 STATE ST. • MANKATO, MINNESOTA

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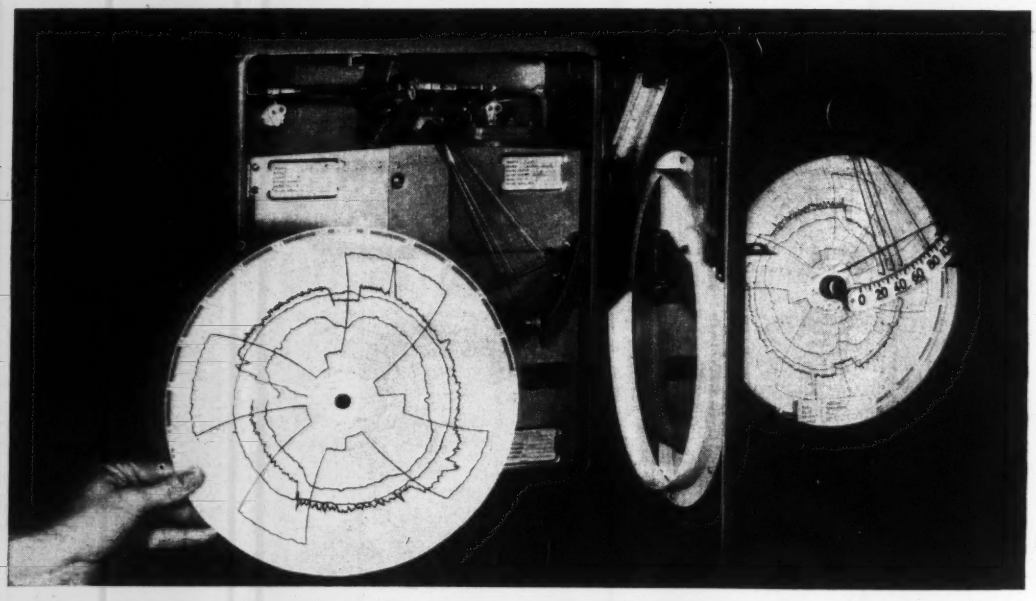


Faithfully yours -

Clear, Continuous Records without Poisoning . . . on the New Bailey Recorder

★ Faithful chart records of measured variables are the key to a meaningful, dependable analysis of operating trends and conditions. Money spent for more accurate metering, for faster response, is money down the drain—*unless* it's matched with chart records that are equally accurate.

That's why these features of the new Bailey Recorder are important to you:

1. Bailey's exclusive sealed capillary-action inking system maintains continuous flow to the pen tip, and traces sharp, opaque, quick-drying records. "Poisoning" of intersecting records is practically eliminated; no blots or smears during operation or chart changing.

2. Pens are mounted on concentric centers, trace on parallel time arcs only 42/1000" apart. This simplifies analysis of two or more records.

3. Interchangeable plug-in receiver units permit practically limitless record-grouping combinations.

Write for Product Specification E12-5 and actual chart sample.

P32-1

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster shipment—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY
METER COMPANY
1041 IVANHOE ROAD
CLEVELAND 10, OHIO
Controls for Power and Process

BAILEY METER

Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW LEVEL
RATIO DENSITY

For more information circle **54** on inquiry card

Ed Koberts (right) consults on an instrument problem in a developmental data-processing system with Richard Prince (left) and Robert Heildelmeier of ARF's Computer Development Section.

"A listing of our research departments illustrates the major lines of endeavor—*Ceramics and Minerals* (John M. Neff, Mgr.); *Chemistry and Chemical Engineering* (Clark E. Thorp, Mgr.); *Electrical Engineering* (Virgil H. Disney, Mgr.); *International* (Paul B. W. Gollong); *Mechanical Engineering* (Gerhard A. Nothman); *Metals* (Robert A. Lubker); *Physics* (Richard H. Humphreys); *Aeromechanics* (Vincent J. Cushing).

"Rapid strides are taking place in materials and components. The impact of magnetics, dielectrics, ferroelectrics, and semiconductors is making possible entirely new approaches to many instrumentation problems." (Pictures illustrating many of these basic activities are shown on pages 704-705.)

When asked what part *I&A* played in the instrument picture at ARF, Ed replied, "We at Armour Research Foundation consider *Instruments and Automation* an important adjunct to our operations and our technical library. I and many others in the organization consult it often and have been doing so for many years, inasmuch as its breadth of material coverage has great utility in an organization of our type. Knowing the availability of commercial instruments is essential to speedy solution of many research problems, and *I&A* reports and displays more such instruments than any other publication, by far. Your *Instruments and Automation Index*, listing all commercial instruments, is of particular value also in this respect."

Ed is a senior member of IRE, a member of Sigma Xi, and a registered professional engineer of Illinois. He served on the board of directors of the National Electronics Conference from 1953 to 1955 and edited the NEC Proceedings in 1953. He also is chairman of the papers procurement committee of the IRE Professional Group on Industrial Electronics and is a member of the IRE Industrial Electronics Standards Sub-Committee, Methods of Measurement.

He also is chairman of ARF's conference on Instrumentation and Control in the Process Industries. The first annual conference held on January 25 and 26, 1956 brought together over 250 specialists in this field from 22 states and Canada.

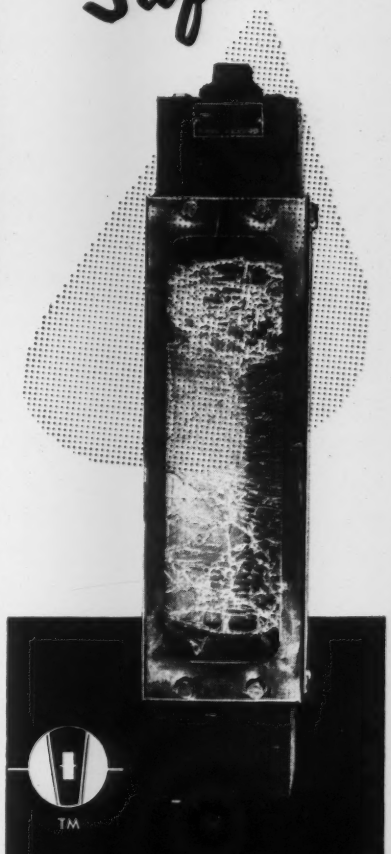
His publications include: "Piezoelectric Crystals as Sensing Elements of Pressure, Temperature and Humidity," *AIEE Transactions*, Vol. 70, 1951; "Meteorological Measurements with Quartz Crystals," *Electronics*, June 1952; "Electronic Instrumentation," *Frontier*, March 1954; "Magnetic Properties of Iron-Nickel Alloys Under Influence of Stress," 1948 thesis, and "Magnetostriction Frequency Control Units and Oscillator Circuits." to appear in the next issue of *IRE-PGUE Transactions*.

Ed also has presented a number of conference papers on various instrumentation and communication topics, including papers on meteorological instrumentation, pressure transducers, frequency control devices and techniques, and magnetostriction frequency control.

Ed resides with his wife, Ruth, and three sons in Lincolnwood, Ill.

BROOKS LEADERSHIP
achieved by design

Safe!



A sudden line surge can pack a mighty wallop.

This Brooks* Full-View* Rotameter, rated at 200 psi, actually was subjected to a hydrostatic surge of well over 750 psi. The metering tube was smashed, slide-plates buckled, safety shielding shattered under the pressure.

But see how the safety shielding remained intact. Broken glass and spurting fluid were safely confined. Personnel were protected from possible serious injury.

Safety shielding is but one of many exclusive design features pioneered by Brooks . . . in the most practical rotameter available today.

For complete details, send for Bulletin 115.

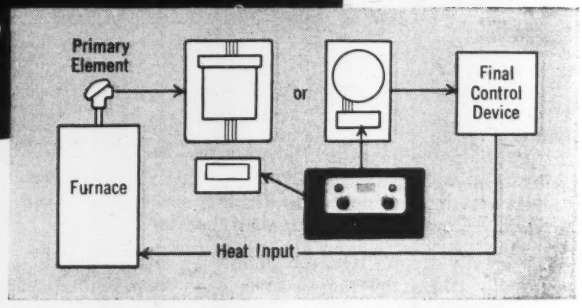
*Trade-Names

A complete line . . . **BROOKS** *. . . for every service*
ROTAMETERS

BROOKS ROTAMETER COMPANY
104 EIGHTH STREET • LANSDALE, PA.

For more information circle **55** on inquiry card.

This control relay is the heart of the new Series 60 electric proportioning control system . . . which also includes a Speedomax® indicator/recorder, a primary element and a final control device.



WITH THIS NEW SERIES 60 CONTROL

You can push your furnace HARDER

■ If you're wasting valuable furnace time bringing a *batch* to temperature . . . slowing down heating rate to prevent overshoot . . . Series 60's adjustable rate of approach will bring furnace to control point smoothly—safely—in shortest possible time.

If you're losing production on your *continuous* processes due to hot spots . . . slow start-ups . . . poor combustion, Series 60's sensitivity, speed of response and control actions will provide fast, uniform heat distribution within the furnace . . . head off temperature departures as soon as they start.

Regardless of your process, if your furnace, your product and your production isn't benefiting fully from your present controls, it'll pay you to look into Series 60.

COMPLETE, FLEXIBLE SYSTEM Heart of this flexible system is L&N's new, compact Series 60 electronic proportioning control relay which receives information from the Speedomax indicator/recorder . . . immediately amplifies it and adjusts the final control device to hold temperature in line. This control relay is only 6″ x 11″ x 11″—about half the size of the Series 50 unit which it replaces. It's an integral part of our new Speedomax H instruments . . . mounts in its own case when used with Speedomax G. Expendable components—tubes, electrolytic capacitors, etc.—are plug-in for fast servicing.

VARIETY OF CONTROL ACTIONS Series 60 is available for Position-Adjusting Type (P.A.T.) or Duration-Adjusting Type (D.A.T.) control.

P.A.T. regulates input by adjusting the position of a valve; D.A.T. provides a two-position operation of the final control device . . . regulates input by adjusting the durations of heat-on time of a contactor, or of full-open time of a valve.

P.A.T. is supplied for single-action (proportional) or 3-action (proportional, reset and rate) control . . . D.A.T. for two-action (proportional and reset) or 3-action control. Proportional regulates input according to *size* . . . reset according to *duration* . . . and rate according to *speed* of temperature change. Choice of type depends upon your product, your process and your production.

In the 3-action units, reset and rate operate independently—permit optimum settings for best possible control. Reset is adjustable from 0-100 repeats/min; first step above zero is .01. Rate time is continuously adjustable from 0-8 minutes.

For a full description of Series 60 control, contact your nearest L&N office, or write 4955 Stenton Avenue, Philadelphia 44, Penna.

LEEDS [LN] **NORTHRUP**
instruments — *automatic controls • furnaces*

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INSTRUMENTS and AUTOMATION

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts

M. H. Aronson, Editor.

Editorial

Automation in Russia

Reflections by **Weldon H. Brandt,** *Engineering Manager, Director Systems Department, Westinghouse Electric Corporation, who has visited Soviet Russia in an exchange arrangement. He was one of a 3-man team who took the 2-week tour. His companions were* **Nevin L. Bean,** *Ford Motor Co., and* **Albert C. Hall,** *Bendix Aviation Corporation.*

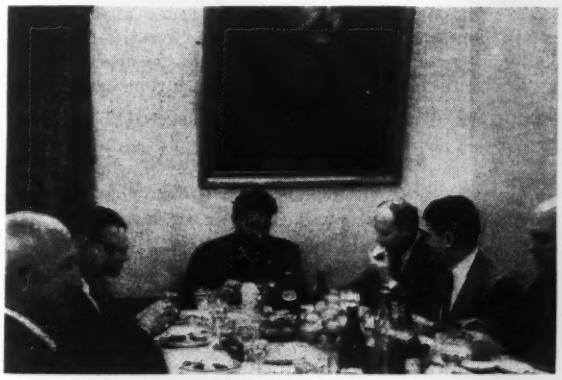
It is fitting that readers of *Instruments and Automation* be among the first to receive this account of Dr. Brandt's visit to Russia because the occasion for the exchange visit of the Russians to the USA was the Second International Automation Exposition, Chicago Nov. 14-17. Dr. Brandt visited many industrial firms, research laboratories, government institutes, etc. His comments on several of these follow:

Russian Institute of Precision Mechanics and Calculating Technology

450 engineers are employed at this Institute. They have developed an electronic digital computer for the solution of scientific problems that uses 5,000 vacuum tubes. It operates 24 hours per day, seven days per week and does the work of 10,000 human operators. Effective operating time on the computer is 72 percent. This Institute reports to the Academy of Science, meaning that basic research is carried out here.

Experimental Scientific Research Institute for Metal Cutting Machine Tools (ENIMS)

About 475 engineers are employed in this Institute which reports to the Ministry of Machine Tool and Instrument Building, and would be called a development laboratory here. The Institute develops and designs various machine tools and has an experimental machine tool plant for construction of first models. A complete bearing manufacturing line, well-automated, was designed here and is in operation at the Kaganovich State Bearing Plant No. 1 in Moscow. Mechanical design work here appears to be rather good, hydraulic servo



Tea with Bulgakov, Head of Machine Building Div., Ministry of Machine Tool and Instrument Manufacture, Nevin L. Bean, L. Khodarkov, Intourist Interpretor, Kozichev, Director of Machine Building Plant named for Ordzhovikidze, Albert C. Hall and Armitage of the U. S. State Department. The bald Russian on the right is unidentified. Since Dr. Brandt took all the pictures shown here, he himself is represented by a studio portrait shown on page 682. Picture on wall is of Ordzhovikidze.

Magnetic tape memories of a computer at the Institute of Precision Mechanics and Calculating Technology. This equipment was of good quality and appeared up to American standards.

work appears to be fair, and electrical work appears to be rather weak, though they have special hydraulic and electric departments. The Institute works on those machines that are considered to be 3 to 5 years ahead of present technology. Less advanced designs are in the hands of the plant design departments, but such designs must also be approved by ENIMS.

Top salary for a straight engineer is 3000 rubles/month—a chief engineer earns 4000 rubles/month; they may get up to 2000 rubles/month bonus as well.

Institute of Automechanics and Telemechanics

This Institute is under the Academy of Sciences and the Director is V. M. Trapeznikov. This would probably be known as a servo telemetering laboratory in the States. Work is done on 3 main lines—(1) general theoretical, (2) digital systems, including Boolean algebra and application in measurement and control systems, (3) automation of industrial processes, largely of consulting nature to industry.

The automatic regulation lab studies nonlinear systems, mainly pneumatic and hydraulic. The work on pneumatic and hydraulic servos is not impressive—better has been done in this country 7 or 8 years ago.

An analog computer used for solving up to sixth-order differential equations, linear and nonlinear, is impressive. Answers are presented on a large scope. The unit is compact and convenient.

Gorki Automobile Factory

Plant has own town, schools, club, cinema, theater, and evening school; many workers get a technical or engineering education.

Assembly practice seems similar to USA; plant has a million square meters of area, 45,000 workers, produces 1000 vehicles/day of which 780 are trucks, 120 passenger cars, 100 agricultural vehicles.

Electronic high-frequency ignition systems have been experimented with—but are considered impractical for automobiles; electrical systems are all 12-volt systems.

The bicycles made at Gorki sell for 620 rubles; the Pobyetta auto sells for 20,000 rubles and has 52 hp; the Zim automobile sells for 40,000 rubles.

Kaganovich State Ball Bearing Plant No. 1

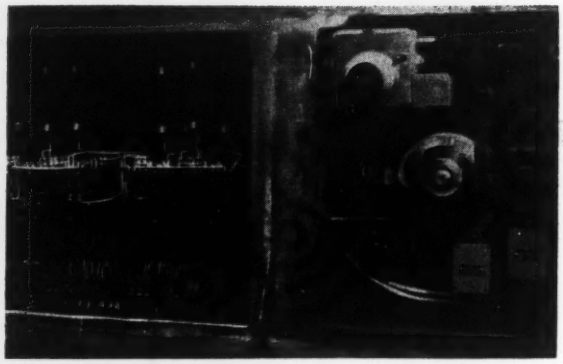
This plant, at Moscow, produces all sizes of bearings; largest weighs 4 tons, smallest 150 grams. Output has increased 60% in last 5 years due to automation and better production lines, organization of labor for better efficiency, and "socialist competition."

Socialist competition is a fashionable word and involves contests between departments and factories; plant employs about 50% women; 100 doctors and 200 nurses serve 12,000 workers and their families or about 40,000 persons in all—emphasizing preventive medicine.

Workers have an opportunity to attend high school and technical school—every worker has a chance for higher education.

Plant area is 360,000 square meters, produces 1300 types of items for a total of 60 million bearings with a value of about 545 million rubles (selling price).

One automatic line is in production and a second is under construction. The automated line has storage at certain points to accomodate various operation speeds—gaging is done at various steps, but no feedback is used at any point—parts out of dimension are rejected—rejects run 1.6% of total.



Control panel of a machine at ENIMS. Similarity to American equipments is apparent.

Pobyetta assembly line uses motor-operated hoists.

Stalingrad Tractor Plant

This plant was visited Dec. 16, 1955. Plant was destroyed during the war and is still in reconstruction; sale price of a tractor is 15,900 rubles.

Plant is profit sharing and is granted a bonus of 800-900,000 rubles annually—50% goes to workers, 50% to engineering staff and social welfare.

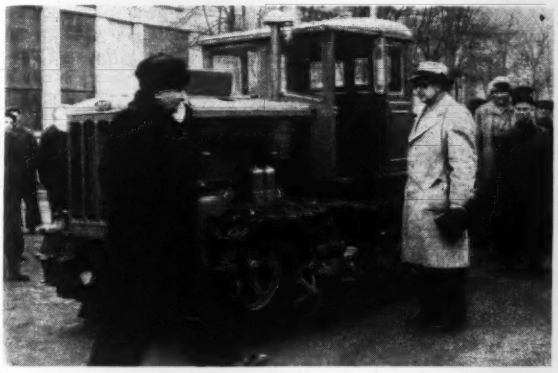
Next to the Director the Chief Engineer is the most important man in the plant, which uses 2500 engineers and foremen. An engineer starts at 8-900 rubles/month but may progress to 2500 rubles as he gains experience. Average wage in plant is 8-900 rubles/month—a few outstanding workers may make up to 3000 rubles/month.

Ministry of Machine Tools

At a conference at the Ministry of Machine Tools, there were many general expressions of friendship. We were

Portion of the automatic assembly line in the Moscow State Ball Bearing Plant No. 1.

Auto body line in the Gorki plant uses women laborers in lieu of transfer machines.



Nevin L. Bean inspects tractor just off the line at the Stalingrad Tractor Plant.

Lathe assembly line in the Krasny (Red) Proletariat Plant at Moscow.

asked to be critical . . . it was stated that criticism is in fashion in the Soviet Union at this time. It was pointed out (by the Russians) that many industrial operations do not lend themselves to automation.

It was stated that they believe it impossible to set up a mathematical description of chemical and petroleum processes to permit design of a truly automatic process. When asked if they had considered computer control of such processes, they replied that this had been considered but had been discarded as impractical.

They are working on transistors with emphasis on junction types—germanium and silicon.

Radio Technology Industries

The Krasny Zarya Factory, under the Ministry of Radio Technology Industries, produces telephone-type relays, switchboards, etc.; is 40,000 square meters in area; employs 5000 laborers of whom 8% are engineers, 5% technicians.

They have a technical school and an evening college.

Production this year will amount to 130 million rubles. Their telephone-type relays are good for 10 million operations.

Average wages are 800 rubles/month; engineers start at 1100 rubles and may progress to 2500 rubles. Bonus can increase pay of outstanding workers to 2000 rubles/month; a shop manager is paid a bonus of 40% of his salary if he fulfills his plans.

Every 3rd or 4th worker attends courses of some kind —but advanced degrees seem to be limited to full-time college students.

Research and development work is separated from manufacturing activities—as at other plants—although they do have labs for plant needs. Operations in general were like those in USA, although stamping and pressing seemed excessively manual.

General Impressions

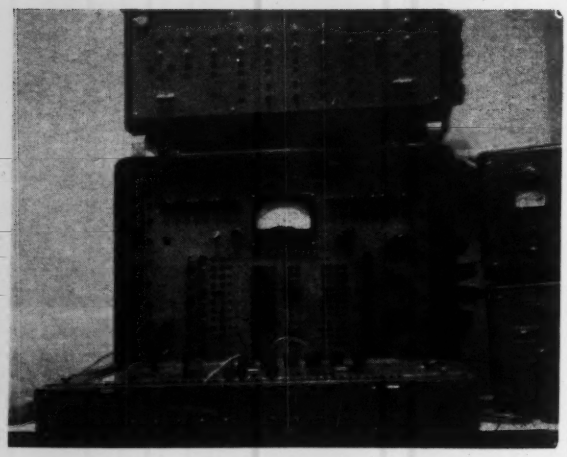
Women are used to a greater extent than in USA.

No men in uniform were seen in factories or institutes visited.

High prices of consumer products (100 rubles for a pair of shoes) show difference between standard of living in USSR and USA.

Academy of Science in USSR plays an important role in engineering life; there are about 100 full members or academicians; an academician gets 5000 rubles/month just for being an academician, plus his salary; a member gets 3000 rubles plus his regular salary. Some are professors; some do research.

Universities have four grades of teaching staff—professor, docent, senior instructor, and instructor. A professor



Analog computer at the Institute of Automechanics and Telemechanics can solve 6th-order equations.

Engine assembly line at Gorki. General housekeeping on main assembly lines is superior—on parts lines inferior—to the typical subassembly line shown. Chain types as above are common.

earns 5500 rubles/month; a docent 3200 rubles/month; an instructor 1350-1750 rubles/month.

University graduates are equivalent to our B. S.; a Candidate of Science corresponds to our M. S.; a Doctor of Science to our Ph.D.

Moscow University has 5-year program; about 96% of students are paid from 290-450 rubles/month stipend, determined by results of examinations. There are foreign students from France, Norway, Iceland, etc.

Post graduate students get 780 rubles/month.

The ruble has an official exchange value of about 25 cents. A recent black market quotation is 10 cents a ruble. When evaluating the standard of living of a Russian on the basis of his income, it is well to keep in mind that the regulated Soviet economy provides essentials (minimal food, rent, and clothing) at cheap "submarket" prices—whereas most other consumer goods carry high price tags. The result is that low-income jobs provide a better standard of living than is indicated by a mere comparison of ruble income vs prices—whereas persons with higher incomes actually can purchase far less than seems to be indicated.

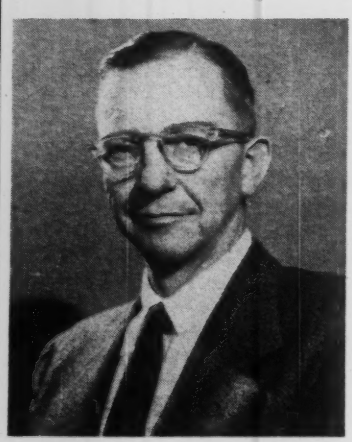
Engineers work on fixed wages plus a bonus.

Any citizen of USSR can apply for a patent; about 20 or 30% of patents granted earn royalty; royalty is paid entirely to the inventor on basis of percentage of profit resulting from inventions; a special government bureau safeguards rights of inventors.

There are "norms" for all workers—bonuses are paid for exceeding normal.

Labor unions organize the workers to fulfill tasks and help the director run the plant—there have been no strikes since 1917.*

**Only "purges."—Ed.*



WELDON H. BRANDT

THE AUTHOR

Selection of **Dr. Brandt** as one of three American experts on automation to visit Soviet industrial and research installations was singularly appropriate. It was also a tribute both to Dr. Brandt himself and to the scope of research, development and manufacturing activities of the Westinghouse Electric Corporation. Since he received his Ph. D. in Physics from the University of Illinois in 1936, Dr. Brandt has been an employee of Westinghouse.

First he worked a year at the Westinghouse Research Laboratories on metallurgical problems, particularly thermostat alloys and glass sealing alloys. Then, in the Materials Engineering Department, he was concerned with the development of magnetic alloys, Hypersil and Type C core materials.

In 1946 Dr. Brandt was named manager of Special Products Engineering and given responsibility for development programs, including all phases of development design and pilot plant manufacture. This job, with its natural emphasis on servomechanisms and controls, kept him busy until 1954, when he became Manager of the New Products Engineering Department.

For a year Dr. Brandt and his newly created department worked on the Cypak static switching systems for industrial control applications. By last year the Cypak systems had become sufficiently advanced to warrant a separate department of their own. Westinghouse termed this the Director Systems Department, and named Dr. Brandt as its Manager of Engineering, a position he holds at this writing. His work involves supervising the further development of magnetic amplifiers and Cypak controls and is concerned with both analog and digital devices.

An Important Issue

THE NEWS item "SAMA Supports House Bill HR 6381" on page 638 of this issue is on a subject of significance to the entire instrumentation industry. The basic function of the National Bureau of Standards, as set forth explicitly in its charter, is to provide standards to American industry. As no measurement in any field can exceed the accuracy of the standard within that field and still have meaning to others, this function lies at the heart of all instrumentation in the United States of America.

The situation discussed in House Bill HR 6381—crediting certification fees to NBS—has to do with a situation that strikes at the basic function of the National Bureau of Standards.

The reasons are as follows:

When an industry asks for standards from the Bureau it pays for the standards, as is fitting. However, the moneys and fees for this kind of work are turned over to the Treasury of the United States by the National Bureau of Standards, as required by existing law. The result is obvious. The more standards supplied to industry, the less money the Bureau has to operate with, simply because it costs money to produce the standards, which money comes from the operating expenses of the Bureau, but the income goes to the Treasury of the United States and not to the Bureau.

This situation is not theoretical or of minor importance. Many companies requesting standards are advised by the department involved at the Bureau to take fewer standards, to take later delivery, or even wait impossible intervals for delivery. This has happened time after time to companies requesting standards from the National Bureau of Standards, even though officials of the Bureau may deny it for reasons political and otherwise.

One political reason has to do with the position of the Bureau in obtaining appropriations for its work. It simply must not offend important people on Capitol Hill. Thus, Bureau officials cannot themselves make use of this situation. They may even deny that this situation exists, but we know that it does and we have seen its effects at first hand.

Another result of this situation is that the Bureau has tended to emphasize auxiliary research activities in relation to its standards activities.

However, so long as the basic function of the Bureau remains that of supplying standards to industry, and in view of the basic importance of maintaining this service at peak efficiency, this situation must not be allowed to exist.

Kenneth Andersen, executive vice president, Scientific Apparatus Makers Association, has called for interest in support of Bill HR 6381, which provides for crediting certification fees delivery to the account of the NBS rather than the general fund of the Treasury. Instrument users and manufacturers are urged to communicate with their own congressmen *and* Congressman J. Percy Priest, chairman, House Interstate & Foreign Service Committee, showing their interest in the bill's passage during this session of Congress.

Background Facts with a Moral

THERE ARE several important lessons to be learned from a discussion arising from a report in the *Simulation Council Newsletter* (February, 1956 *I&A*) of a meeting of the Western Simulation Council. The point in question: A discussion of the EPSCO conversion equipment designed to tie together an Electronic Associates' 300-amplifier analog-computer system and a Remington Rand 1103A digital computer to perform a 3-dimensional simulation of tremendous proportions; the job is part of a weapons-system under development at Ramo-Wooldridge Corporation. The requirements as to speed and accuracy on the part of the conversion equipment are indeed staggering—and the men who came to this meeting wanted to know how the system worked.

They were not given the details they sought, and they exhibited a natural skepticism about the ability of the equipment to meet specifications that seemed to be above and beyond the present state of the art.

As the *Newsletter* is a discussion mart, and as it is fortunate in having a fearless and talented editor who accurately reports both the contents and tone of its meetings, the skepticism exhibited by the men at the meeting was reflected in the *Newsletter* account and was, because of the mass circulation and high reader interest of *I&A*, propagated far and wide.

The purpose of this editorial is to set this matter in proper perspective. As a paid-circulation magazine, and the leader in the field, our first interest is our readers, to whom we bring as much honest reporting and educational material as we can pack into our 200-page monthly issues. The *Newsletter* report was an honest report of the meeting—this is only to add some educational background material so that the report can be put into proper perspective by our tens of thousands of readers.

Fact 1: EPSCO has undertaken several large conversion jobs whose specifications seem in advance of the present state of the art.

Fact 2: EPSCO equipment is already in operation at Shell Oil Development Company (Emeryville), Lincoln Laboratories, MIT, and other places. The Shell Oil DATRAC equipment can make a complete digital-to-voltage conversion in 1 microsecond and an analog-to-digital conversion at a rate of 1 binary digit in 2 microseconds. The Lincoln Laboratories system makes 160,000 independent voltage-to-digital conversions per second, with an accuracy of 0.5%.

Fact 3: The original installations of Model B and Model A DATRACs at Lincoln Laboratories and the Acoustics Lab, MIT, have been in operation for over a year. The unit at Project Lincoln has been intermittently used as part of a weapons-system development program, while the installation at the Acoustics Lab has been in continuous operation, performing with high reliability and low maintenance.

TI PROGRESS REPORT ON
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TI line of silicon transistors and diodes and stockpile of grown silicon crystals.

TWO YEARS AGO the first silicon transistors were put on the market by Texas Instruments. Enthusiastic acceptance of these high gain, high temperature units has allowed Texas Instruments to repeatedly increase production and reduce prices because of improved mass production techniques.

TODAY, after outstanding field performance under rigorous conditions, TI silicon transistors and diodes are being installed in mass-produced equipment by increasing numbers of electronics manufacturers. You can now select from TI's broad line of silicon transistors . . . the widest choice on the market . . . allowing for *complete* transistorization of many circuits.

THE 8 TYPES of TI grown junction silicon transistors range from high gain, low level units to high gain power units with up to 8.75 watts dissipation. Also, Texas Instruments produces 55 types of single crystal fused junction diodes . . . general purpose diodes in 13 voltage ratings . . . voltage reference diodes in 42 voltage breakdown ratings.

WHEN YOU PLAN transistorization or miniaturization, contact Texas Instruments first . . . your most experienced source for semiconductor devices – silicon or germanium transistors, rectifiers, and diodes.

YOUR CHOICE OF 8 SILICON TRANSISTORS

4 high temperature small signal transistors

For reliability and economy at high temperatures. Dissipation at 150°C, 50 mw; at 25°C, 150 mw. Maximum collector voltage, 30 volts.

type no.	alpha	alpha frequency cutoff (mc)	gain (db) (design center)
903	0.9 to 0.95	4 (Design Center)	30.5
904	0.95 to 0.975	5 (Design Center)	34
905	0.975 (Min.)	6 (Design Center)	36.5
904-A	0.95 (Min.)	8 (Minimum)	35

3 high temperature medium power transistors

For audio and amplifier stages. Dissipation at 150°C, 150 mw; at 25°C, 1 watt.

type no.	alpha (minimum)	collector voltage (maximum)	gain (db) (minimum)
951	0.9	50	30
952	0.9	80	30
953	0.9	120	30

high temperature power transistor

For output power stages, as in servo amplifier outputs. Dissipation at 100°C, 3.5 watts; at 25°C, 8.75 watts.

type no.	operation	output (minimum)	gain (db) (minimum)
970	Class A (100°C)	1 watt	28
970	Class B (100°C)	2.5 watts	18

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EDITORIAL—CONTINUED

Fact 4: The advanced and "impossible" systems discussed at the Ramo-Wooldridge meeting have not yet been delivered, and thus cannot yet be inspected in operation except by invitation of EPSCO.

Fact 5: The first system of this advanced type will be installed at CONVAIR, San Diego, near the middle of the year.

Fact 6: EPSCO has engineered the (1) Model A DATRAC which can translate voltage data into parallel digital codes at 200,000 codes per second; (2) Model B DATRAC that translates up to 50,000 voltages into parallel or serial codes per second; (3) Model E DATRAC with accuracy of 0.01%, for driving electric typewriter or card punch; (4) Radar Return Data Conversion system at Project Lincoln; (5) Inertial Reference Data Recorder at Instrumentation Lab, MIT; (6) Multiple Channel Computer Conversion Equipment—the subject of the *Newsletter* report; (7) Data Conversion and Communication Link—a Classified Confidential system; (8) DATRAC C System that converts 18 voltage inputs simultaneously into 4-place decimal notation, and (9) computer-controlled data reduction system for a cracking plant. Approximately 200 ultra-high-speed converters have been completed or are now in process by EPSCO for data reduction systems and for data translation between analog and digital computers.

Fact 7: All this has been done by a firm not yet 2 years old, with no government support or assistance, and with the backing of no large corporate structure.

Fact 8: Owing to its "bootstrap-lifting" development, EPSCO is jealous of its proprietary techniques. For example, it uses encapsulated circuits that cannot be altered by the user, circuitry is held fairly confidential, etc.

The lessons to be learned from all the above: (1) Any firm has a right to guard its proprietary techniques, but (2) engineers in any field will be skeptical of specifications that appear in advance of the state of the art as they know it and about which they can get little detailed information. (3) There is no reason to doubt that EPSCO Incorporated can deliver on any of its contracts despite the dramatic specifications therein; although such doubts were reflected in the *Newsletter* report, the performance of EPSCO Incorporated to date—which has been reported here—leaves little basis for such conjecture. (4) The rise to a prominent position in the field in just 2 years, without the conventional hidden backing of Federal or corporate "loss-seeking funds," is a tribute to the firm of EPSCO Incorporated—and a heartening example of the best elements of our private enterprise system at work.

—MHA

Report on the 1956 IRE Show

THE STATISTICS on the 1956 Radio Engineering Show and IRE Convention reflect the vast scope of the American electronics industry—275 papers at 55 technical sessions, 45,000 registrants, 714 exhibitors on 5 acres of floor space, etc., etc. Not even 13 inches of snow, which paralyzed New York transportation, could interfere with the activities of this great event.

Pages could be written on any of the major subjects covered in either technical sessions or exhibits, on medical electronics, ultrasonics, air traffic control, etc., etc. By necessity, this show report must confine itself to a few of the many interesting subjects that could be discussed. As readers of *Instruments and Automation* are probably most interested in the newest instrumentation revealed at the exposition, we will confine this report to a general discussion of the newest aspects of the exhibit, plus a brief mention of some of the newer instruments.

Emphasis throughout the vast exposition seemed to be on components, with many new lines tailored to the needs of printed circuitry. Of interest was the increased emphasis on inertial navigation systems, a byproduct of the Federal missile and earth satellite programs. The large attendance at the Symposium on the Earth Satellite Program also revealed the high interest in this new field. Although many of the exhibited inertial navigation elements (platforms, gyroscopes, etc.) were not "new" to the field, much hardware that never before has been seen in public was on exhibit. Emphasis on gyros was correspondingly high, and the M-H exhibit, featuring a recorded display of the sway rate of the Empire State Bldg. (from a gyro mounted on the 88th floor of the building), attracted much attention. The "world's smallest rate gyro" was shown by the United States Time Corporation; stable platforms and gyros were exhibited by Kearfott; other navigation aids were exhibited by Ford, Norden-Ketay, and others.

Related to the same field was the high interest in telemetering, essential to the performance analysis of missiles, aircraft and satellites. Several important papers were delivered on the subject.

Modular construction and printed circuitry is fast becoming standard in many electronic circuits.

The following listing of new products exhibited has been chosen to show the state of the instrument art, as revealed at the IRE Show and interpreted by your editors. The first few items in particular are characterized by new principles or features of extraordinary importance. Note the emphasis on digital readouts (of instruments, counters, computers, etc.), tape handlers, new recording techniques and automatic features for analog computers.

1. New electrophotographic recording oscillograph of Century Electronics uses Electrofax charged paper to give a recording that can be viewed in less than a second after exposure. Features include daylight loading, traces that can cross each other, and frequency response from 0 to above 200 cps (using galvanometers with a natural frequency response of 90 cps). The model shown (Model 420) had 24 galvanometer light-beam recording channels.

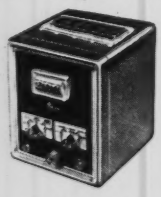
2. New 8-channel direct-writing and direct-reading oscillograph recorder of Acton Laboratories, using 8 galvanometers and styli. Each stylus scribes a waveform on 35-mm acetate film coated with carbon. A plastic spray fixes the image to provide a permanent record. Test results can be seen instantaneously through a projection

New concept for HIGH-SPEED TESTING

In just 1 to 2 seconds average, using Hycon's new Model 625 Ratiometer, you can measure directly the ratio of two related DC voltages. It's a real money-saver for quality-control testing on component production lines . . . brings new accuracy and speed to telemetering, measuring VSWR and reading remote transducers. Although completely new, there's no special training needed, for error-free readings are made *directly* on the fast, reliable* 3-digit counter.

*Hycon counters are specially engineered for long service . . . prototypes have been continuously cycled in excess of 1,000 hours . . . the equivalent of at least 20 years of average use. Counters backed by unqualified, continuous-use service guarantee.

Another Hycon test help . . .



MODEL 615 DIGITAL VTVM

Features fast, error-free readout on a reliable, illuminated decimal point 3-digit counter.

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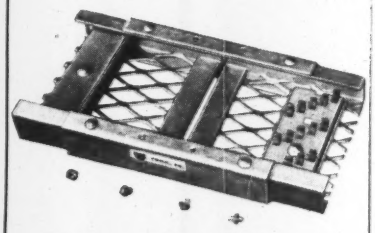

P-W Manufactures a complete trough system with channel connectors. Drive rivets are used for quick assembly.—Extension Connectors eliminate field cutting—Adjustable connectors for any change in direction or elevation—I Section for long spans—Tube Clips—Cushion Clamps

Raceway to support a limited number of tubes with connectors, elbows, tees, etc.—Bulkhead Bar. P-W systems are available in widths from 1" to 24" and in lengths from 1' to 16'.

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system. Frequency response is up to 1,000 cycles.

3. New "Atomichron," a primary frequency standard offered by the National Company, is based on the resonance frequency of cesium, and offers a stability of 5 parts in 10^{10} parts as an elapsed-time-measuring instrument.

4. New transistors produced by "grown-diffused" technique and usable to over 100 Mc, and which will oscillate above 250 Mc—by Texas Instruments.

5. Power silicon transistor (8 watts) and new microminiature tube line by General Electric.

6. New Honeywell weld-seal transistors.

7. Cathode-ray display devices with not only brilliant images but also controllable persistance, by Hughes Aircraft. The "Memotron" features a trace that is applied in a conventional manner by electrostatic deflection plates, but which uses an electrostatic storage mesh to retain the signal until erased. Successive traces can be placed on the tube for comparison purposes. The "Tonotron" display features brilliant images and controllable persistance for PPI radar and similar displays.

8. New, small, and exciting portable digital differential analyzer of Litton Industries, featuring 20 integrators, 46 tubes, and 520 diodes in a complete DDA unit smaller than a typewriter.

9. The Elecom 125 system electronic computer of Underwood Corporation was shown in operation with the Elecom File Processor, an automatic data-handling unit which sorts, collates, selects and categorizes information recorded on magnetic tape.

10. Unique and inexpensive analog-to-digital converter (LiAD) of Assembly Products, featuring a D'Arsonval movement and pointer; pusher bar presses pointer against coded plate with contact-type elements, giving coded output. Fastest operation is about 2 operations per second; resolution is 2%.

11. New volt-ohmmeter of Hickok featuring circuit breakers on input to provide burn-out-proof feature.

12. New "Iconumerator" of DuMont, an automatic area scanner that counts up to 10^6 particles per second, and which has a particle resolution of 0.004 inch.

13. Graphic panels by the "Lackon" process of Sun Dial Corporation, providing needle-sharp symbols on a wide range of materials—metals, plastics, glass, etc.

14. New inline digital readout of Berkeley Div., Beckman, based on 7 line segments.

15. New 24-channel dynamic visual monitor of Century Electronics, which projects 24 spots of light on 24 adjacent scales to present a dynamic bar-graph. Short-period galvanometers offer 79-ua full-scale sensitivity.

16. New all-electronic analog-to-digital coder of Radiation, Inc., which provides 24,000 8-bit codings/sec in a unit weighing only 8 pounds; also the analog-to-digital-to-analog recording system of Radiation, Inc.

17. New voltage-comparison-type analog-to-digital converter of the Atomic Instrument Company, featuring 5,000 codings/sec; 3-digit output plus sign.

18. New Magnistorized counter of Potter Instrument for counting at rates to 50 or 100 kc, using a 1-kc tuning fork standard. Also Magnistorized shift register for transferring parallel or series digital pulse trains at rates up to 100 kc.

19. New adjustable nonlinear-function generator based on the Vernistat of Perkin-Elmer Corporation, which sets and adjusts a tapped Vernistat at 31 points to 0.5%.

20. New "400 Series" REAC analog computer of Reeves, featuring control of the computer from the recorder, and a new recorder with many remote-control and automatic-calibrating features.

21. New Beckman "EASE 1200" analog computer featuring punch-tape problem setup. Operator at Flexowriter sets data onto punch tape, which automatically sets the computer coefficients, initial conditions, and bias voltages.

22. First showing of the new "A14 GEDA" analog computer, featuring patch panels tailored to the needs of both simulation and equation solutions, by Goodyear.

23. New features of the PACE analog computer of Electronic Associates include automatic printout of any amplifier output or of any point on the patch panel, new servomultiplier, and a new 6-channel recorder.

24. A magnetic-core memory system (DICS) of Daystrom, featuring printed circuit technique, 8,000 bits, access time of 7 microseconds (time to read one 8-bit word out of the memory and write another one back into the memory) in a unit 4½ x 4½ x 13½ inches; any matrix configuration and any number of planes are possible.

25. New (and important for doctors and nuclear physicists) a-c-operated condenser r-meter of Victoreen, the accepted secondary standard for the roentgen throughout the world. Also, a much needed low-energy survey meter for beta and gamma measurement in an r-f field, which can be used for monitoring near projection TV, high-voltage equipment, etc.

26. A ten-channel digital pressure-measuring system accurate to 1 part in 1,000 by Byron Jackson, based on the Vibrotron.

27. Transistor test set that measures leakage current and shorts in a common emitter circuit and transistor d-c gain, by Measurements Corp.

28. A character display system for displaying numerals on the screen of a cathode-ray tube at a rate of 10,000/sec using the dot sequential system, by Wang Laboratories.

29. Expanded line of thermistors by General Electric, Carboloy Dept.

30. Magnetic-core and junction-transistor modularized circuits (logical elements, shift registers, etc.) by Ferranti.

31. New tape handler of Potter Instrument, featuring 3-millisecond start-stop time.

32. New "Snapper" thermal time-delay relays of Curtiss-Wright Corporation, featuring snap-action temperature-sensitive switches.

33. Relays with terminals for printed-circuit use by Automatic Electric and capacitors with printed circuit terminals by Southern Electronics Corp.

34. New EPIC square-pulse generators that provide 4 simultaneous outputs in the millimicrosecond range.

35. New high-temperature accelerometers of Gulton Industries, which can be used to 500° F without cooling.

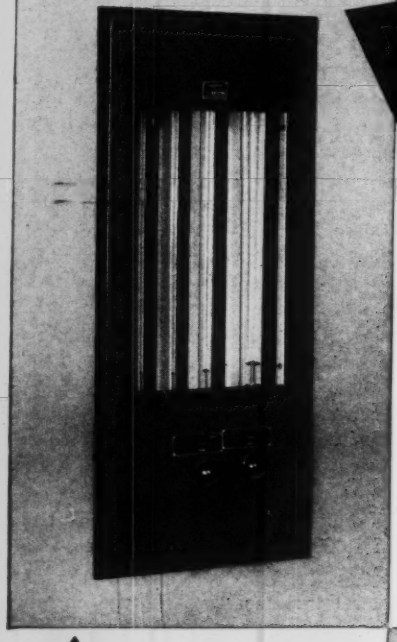
36. New temperature-stable piezoelectric material for transducers, by Endevco.

Holds No Terror

TYPE II VISCOMETER

A new laboratory-field instrument, using advanced flow system design, which quickly indicates kinematic viscosity of fuels, oils, weak acids and other base solutions. Two ranges available: .5 to 5.0 and 3.0 to 30 centistokes. Readability: within 1%. Portable or panel mounted.

COX INSTRUMENTS *prove this day-in-and-out* IN THE LABORATORY . . ON PRODUCTION LINES



Forty-three years ago, Commercial Research Laboratories produced the *first* precision Cox instruments — far advanced for their day. The name Cox has since become synonymous with accuracy and reliability wherever testing devices are used. So much so, in fact, that scores of aircraft, automotive, and hydraulic equipment manufacturers — here and abroad — have made a common practice of *calling in CRL first* — for expert advice in the design, development and manufacture of *any* hydraulic or air flow measuring device, large or small.

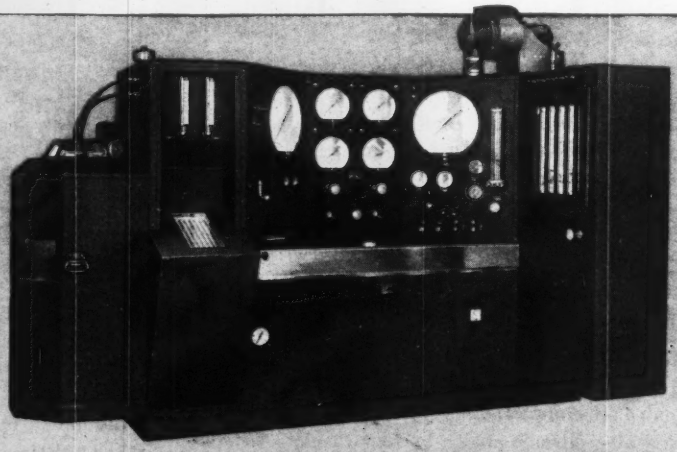
If your own requirements call for the smallest production-model flowmeter, or the most intricate, complete test stand — call in CRL first. Save time—and get dependability *plus* accuracy.

TYPE 12 FLOWMETER

Available in three series — 40, 90, 100 — Cox Type 12 Flowmeters combine high precision performance, outstanding readability, and unusually low cost. All Cox Flowmeters — including the Single Stage Type 8, the automotive Type 10, and the Type 14 for pressures up to 1000 p.s.i. — feature patented "Inner Wall" guides which permit individual matching of tube and float for optimum results.

TYPE 416 UNIVERSAL FUEL NOZZLE TEST STAND

A complete testing "laboratory" designed and built by CRL for determining optimum efficiency of jet airplane fuel nozzles. Now in use by the U.S. Air Force and others. Other CRL products include Cox Calibrating Stands, Carburetor Flow Stands, Magnetic Thickness Gages, Balanced Electronic and Vibration Recording Equipment.



C R L

For more information circle **60** on inquiry card.

EDITORIAL—CONTINUED

37. New digital recorder counter of Hewlett-Packard Company, featuring printout of counter data. Also, new line of h-p oscilloscopes.

38. Miniature self-balancing potentiometers and miniature magnetic tape recording system of Autonetics, Div. of North American Aviation.

39. New voltage-ratio indicator with digital readout for checking and calibrating slidewire pickups, by Fairchild Electrotechnics.

40. New phase analyzer and VTVM (one instrument) by Magnetic Amplifier.

41. Hycon digital readout instruments now have digital printout.

42. New pulse generators by DuMont featuring rise time of 0.5 millimicrosecond.

43. A new laboratory-standard volt-ohm-milliammeter by Simpson Electric, and also the "world's first commercially available 100,000 ohms per volt volt-ohm microammeter" by Simpson.

44. New high-powered magnet charger of Radio Frequency Laboratories; also a frequency calibrator-receiver-amplifier-mixer unit for calibrating r-f equipment.

45. New 60-channel oscillograph with a writing speed of 30,000 inches/sec by Heiland Div., Minneapolis-Honeywell Regulator Co.

46. New NRC Alphatron ionization vacuum gage ruggedized to the point where shock, water vapor, and accidental exposure to atmospheric pressure will not harm it.

Pittsburgh Steel Conference

THE PITTSBURGH Section Instrument Society of America held its Sixth Conference on Instrumention in the Iron and Steel Industry early in March. Twelve papers were given covering instrumentation on open hearths, blast furnaces, boilers, re-heat furnaces, and other steel plant equipment, as well as allied subjects. Highlights were a talk by Mr. T. Land, who flew in from England to describe a new suction pyrometer, and a panel discussion on pneumatic vs electronic control.

Attendance of 225 people surpassed last year's conference registration. J. Ward Percy of U. S. Steel's Fundamental Research Laboratory delivered the introductory speech.

The well-attended exhibit which ran concurrently brought a number of first showings of instruments and equipment which included: a new maximum-minimum dial thermometer by Palmer, the Land suction pyrometer (handled in the U. S. by Fielden Division), a new Brooks armored flow indicator, Leeds & Northrup's new Type K-3 Universal Potentiometer, Bailey Meter Co.'s Heat Prover for combustion analysis, Fielden's new Pneutronic capacitance-type level controller, Femco's new multichannel Audio Tone control system utilizing a single pair of wires, and Hidy Brown Recorder Co.'s Degree-Day Counter. Also of particular significance was the unveiling of a complete new line of process control instruments by Weston Electrical Instrument Corp.

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Thomas Land (center) shows the new Land Surface Pyrometer to Carl Yaeger (Chief Combustion Engineer, Jones & Laughlin Steel Corp., Cleveland) while Chas. Swartwout (The Swartwout Co.) looks on at the Pittsburgh Iron & Steel Conference. Mr. Swartwout later took the electronic side of an exciting debate on "Electronic vs Pneumatic Control" at the Conference.

INSTRUMENTS and AUTOMATION will publish all papers in subsequent issues. Proceedings of the entire Conference will be available in bound form.

Dear D.R.*:

We rushed back from the IRE Show this month so that you could get an early report on this vast event. It's on pages 185-187.

As you know, the storage element is one of the key components of a computer. Garry Hollander's article "Data Processing with a Quasi-Random Access Memory" on pages 690-694 is extremely important because it brings out clearly the different requirements of a computer memory for each specific problem—and introduces the new technique of quasi-random access. Don't miss this one.

Next month Klein, Williams and Morgan will bring you a tremendous article on analog-to-digital conversion; they lead up to it this month with an article on digital-to-analog conversion. This also is "must" reading this month.

The novel use of a magnetic coded track in Dundovic's article "Linear Feed Rate Indicator" may suggest some interesting instrument applications to you, and the dollars-and-cents discussion of Kendall Moll in the article "Estimating Electronic Equipment Costs" brings out many little-appreciated costs.

As there is lots of practical dope in both Chet Beard's article "Mechanical Features of Control Valves" and Claude Nolte's "Principles and Practice of Orifice Metering," you are going to need a little extra time to absorb all the material we are sending you this month. Hope this finds you well and happy.

Cordially,
Milt and the Editors

*Dear Reader

Electronic data processing machines require storage capacity for large volumes of information. The TapeDRUM offers quasi-random access, a compromise between the conflicting requirements of large storage capacity and high-speed random access. Here is a clear and thorough introduction to the new technique of quasi-random access.

Data Processing with a

DIGITAL COMPUTERS and data processors contain the same basic elements (Fig. 1) whether used for business or scientific applications. However, business and scientific applications have different and often opposite requirements, and the elements of a digital computer for business applications must differ from those for a scientific computer. The reasons are that business applications require large memory capacity but cannot take advantage of many costly features needed for scientific problems.

Although the distinction has been made between the two types of computers on the basis of "scientific vs business," it is obvious that the latter field includes the areas of data processing and data reduction wherever large numbers of individual pieces of data must be stored. This includes many problems in industrial data recording and instrumentation.

The elements of Fig. 1 are combined to meet the requirements of the given application. The basic specifications can be reduced to the following five factors:

1. Speed
2. Memory capacity
3. Flexibility
4. Self-checking features
5. Cost

For a given design technique, if four of these are specified, the fifth is determined. Each application has an optimum combination of the basic five characteristics; the combination that is good for one application is not necessarily practical for another. For example, business computations require only the simplest arithmetic operations—namely addition, subtraction, and multiplication. Who would ever take the cube root of the payroll? Without frequent iterative operations, the arithmetic element does not have to operate faster than the access time to the needed information in storage.

A computer designed for scientific problems, however, may perform thousands of difficult arithmetic operations on but a few hundreds of pieces of input information. The memory need not be large, the input and output devices can be inexpensive, but the arithmetic unit must be fast and versatile.

In contrast, business applications require the storage of hundreds of thousands of pieces of information, and the computer may perform only a few simple operations on each piece. Here the memory must be able to store a large amount of information, the input and output devices should be highly efficient, but the demands on the arithmetic element are small. The memory becomes the key element.

For these reasons, after looking at the various elements of a digital computer we will focus particular attention on the memory. Although each type of memory has certain advantages for specific applications, a novel storage idea[1], the TapeDRUM*, permits a different approach to large-volume data storage as normally encountered in business and in many data reduction applications. As the TapeDRUM is a new tool, a new set of concepts for the storage of data are developed which yield practical large-scale data-processing systems.

Fig. 1 shows the five basic parts of a typical data-processing system. The arithmetic unit performs the arithmetic operations. Intermediate and final results are stored in the memory. The computer communicates with the outside world via the input and output devices, such as keyboards, typewriters, tape readers, card readers, and similar devices. The operation of these four components is coordinated by the control unit.

Let us now look at these units separately. Probably

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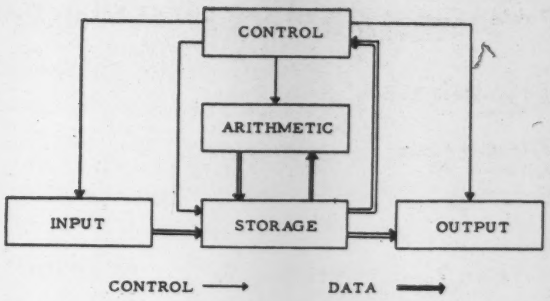

Fig. 1. All digital computers have these basic elements—input-output elements, storage device, arithmetic unit, and control unit. Elements have different requirements if use is in scientific calculations rather than in business or data processing.

Quasi-Random-Access Memory

the easiest way is to examine a very simple arithmetic operation where we multiply:

12 × 23		ab × cd
24	step 1	ab × c
36	step 2	ab × d
276	step 3	Σ of prior products

As the first step, the computer multiplies 2 × 12 and stores it in a temporary memory. As step two, it multiplies 3 × 12 and again stores it in a temporary memory location. In the third step it adds the two intermediate results. Note that three separate arithmetic operations are performed, and the results are stored until they are needed for further computations. This process is the same as if we had carried out the computation with pencil and paper.

Arithmetic Unit

The *arithmetic unit* performs the individual computations (such as the three steps in our simple problem). The speed with which such computations must be performed determines to a large extent the cost of the arithmetic element. For simple computations (such as the one illustrated) a speed of only 1000 computations per second might be adequate. On the other hand, when we have to solve complex differential equations or to invert matrices, the computer must go through trial-and-error procedures, and may make several thousand trials before one intermediate result is obtained. Many of these intermediate results are needed before one final result can be obtained. We obviously want to have the arithmetic element operate as fast as possible, preferably one million additions per second.

These iterative, or trial-and-error, solutions occur often in scientific problems, but normally not in straight business, accounting, and data reduction applications. Therefore, it would be economically wasteful to use a high-speed arithmetic element for such simple processes because we would pay for a feature that would not normally be used.

Control Unit

The *control unit* tells the arithmetic element what operations to perform and where to store its results. In our sample problem, it would instruct the arithmetic element to perform each one of the three steps, one after the other, and after each step it would tell it specifically where to place the intermediate results. At the end of that computation it would further tell the arithmetic element what its next assignment is.

The complexity of the control unit determines the versatility of the computer. If a computer is to be used as a central installation for a university where the chemistry professors worked on a crystal lattice yesterday, the aeronautical department wants to determine the design of an airplane wing today, and the economics professor tries to predict the fluctuation of the stock market tomorrow, the control must be flexible because of the wide range of possible assignments for the computer. On the other hand, basic accounting methods have not changed for many decades, and auditors would raise an eyebrow if we attempted to change our basic bookkeeping procedures even once a year. Thus, for accounting-type data processing, the control element has a simple job that does not change often. This again leads us to the conclusion that it would be wasteful in many business data-processing systems to include a high degree of flexibility using the high-cost control units of a larger all-purpose scientific computer.

Input and Output Devices

In a scientific problem, little information is fed into the computer compared to the amount of computation that is performed on these data. On the other hand, be-

Table 1.—Memory Cost (per Bit) vs Access Time

		Cost Per Bit	Access Time Sec.
1. High-Speed Random Access	Ferrite Cores	$1.00	10^{-6}
	Cathode-Ray Tube	$1.00	10^{-6}
	Vacuum Tubes	$10.00	10^{-6}
2. Medium Access	Magnetic Drums	$0.01	10^{-2}
3. Slow Access	Magnetic Tape	$0.0001	10

Table 2.—Specifications for the TapeDRUM

Drum diameter	12 inches
Drum speed	1200 rpm
Number of tracks	128
Track density	10 tracks/inch
Tape advance speed*	5 pages/second plus 0.25 second
Recorded pulse packing	100 pulses/inch
Recommended storage	10—400 pages
Approximate capacity of one page	200,000 binary digits

*This means that a single page advance requires 0.45 second, but that 10 pages can be advanced in 2.25 seconds.

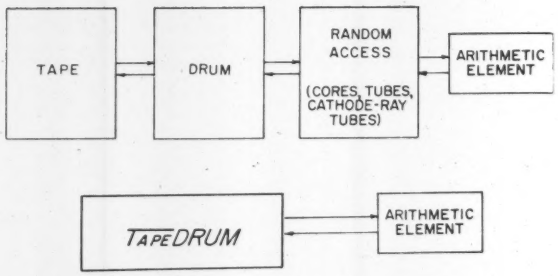

Fig. 2. Conventional data-processing computer may require tape, drum and random-access storage devices to supply information to the arithmetic unit; TapeDRUM can often meet the requirements alone.

cause each individual business problem is so simple, a large amount of information is fed into the computer, and many results come out of it. This means that input and output devices are much more important in the business computer than they are in a scientific computer. Furthermore, business computers must be operated by clerks who may not have had a college education, so the input devices must be more automatic than similar units used with a scientific computer operated by graduate engineers and mathematicians.

Thus, because the business machine has a proportionately large transfer of information into and out of the computer, and because the operators cannot be expected to have a technical skill comparable to operators of scientific computers, the input and output devices will be proportionately more complex in a business computer than in a scientific computer.

Computer Memory

Computer memories are used for two distinct purposes —(1) storage of intermediate results and (2) long-term storage of tables and accounts. Intermediate storage was illustrated in our sample problem, where the products of step 1 and step 2 were stored until the computer was ready to add them during step 3.

As the number of intermediate results is limited, the storage capacity for intermediate data need not be large. On the other hand, because the computer operates on intermediate results, it is necessary that the computer be able to reach these intermediate results quickly.

Information that needs to be retained permanently can be stored in a memory which requires more time for access but which has a much larger storage capacity. For example, the inventory records of a mail-order house require many million digits of information storage. As the cost of computer storage devices are closely linked to the access time, it would obviously be uneconomical to store large amounts of data permanently in the high-cost devices normally used for temporary storage. Table 1 shows order-of-magnitude cost of various memories.[2]

The cost of a computer element is normally specified in cost per bit. (Those familiar with computer terminology know that it takes somewhere between four to seven bits to represent a decimal character in a data-processing system.) Access time means the time necessary to extract the desired information from the memory after a decision has been made to obtain this item. This may be likened to the time necessary to find a word in a dictionary or a name in a telephone book. In serial-access memories, the larger the memory the longer the access time for any one item.

High-speed random-access memories are exemplified by cores and tubes. These are normally used to store intermediate results for a high-speed arithmetic element and to transfer data from an arithmetic element to a slower storage device. Note that the access time is only on the order of one microsecond, but the cost per bit is high.

A typical example of a medium-speed access device is the magnetic drum. While the cost per bit is 1/1000 of that of a tube, the access time is 10,000 times as long. Drums often can serve as intermediate storage devices for slower arithmetic elements which might be suitable for business computers, and to store tables and similar medium-speed access information for a scientific computer.

Even if we had to spend only a penny per bit for all information, it would cost several million dollars merely to store the information for a business which requires 100 million decimal digits of storage. For those applications, therefore, magnetic tape is used; about 100 digits can be stored for 1 cent. Of course, by using a magnetic tape, we lose access time, so that it now takes seconds or minutes to get a piece of information.

Because of the high cost of the high-speed memory, most information is stored in the lower cost memories and transferred via the high-speed memory to the arithmetic element when it is needed. Fig. 2 shows how a typical large-scale computer can call in data to be processed in the arithmetic element. Note the many steps necessary to get the information from tape to drum to random-access unit, etc. With so many steps, the arithmetic element must be fast, which implies that it is expensive.

The TapeDRUM (Fig. 3) combines large storage capacity with relatively fast access time at a reasonable cost. Using the same basis as above, the cost to store a bit of information on a TapeDRUM is on the order of $0.0001. Listed in Table 2 are the design specifications for the TapeDRUM.

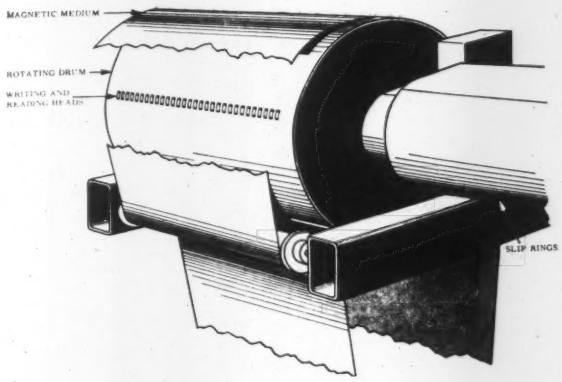

Fig. 3. Details of TapeDRUM, showing how the magnetic medium passes over the heads in the rotating drum.

Within any one section, the access time on the TapeDRUM is equivalent to the access time of a drum. This permits the direct communication between the TapeDRUM and the arithmetic element, making unnecessary an intermediate random-access memory. As fewer steps are now needed, the arithmetic element can operate more slowly, and consequently will be less expensive.

The TapeDRUM (Fig. 3) may be thought of as a drum turned inside out. In a standard drum the information is stored on the circumference of the drum, and stationery heads scan the data as the drum revolves. In the TapeDRUM a piece of tape that contains the information is held stationary over the drum, while 128 magnetic heads, imbedded in the drum, rotate and scan the stationary magnetic surface.

Unlike a standard drum, the storage capacity of the TapeDRUM is not limited by the available circumference of the drum. If the capacity of the drum circumference is exceeded, a new section of the tape, called a *page*, can be moved into position to be scanned by the drum. As show in Fig. 4 many pages of tape can be stored in a bin or on reels to extend the capacity of the TapeDRUM to 100,000,000 bits of information or more.

Two interesting technical features should be pointed out. The tape actually does not touch the drum but is separated by a thin boundary layer of air. This minimizes tape wear. The exact position of the tape on the drum is not critical because the reference information is recorded on the tape along with the useful data.

We can then see that while most of the information on the TapeDRUM is stored on inexpensive tape, we gain many advantages of a drum:

1. *Higher relative velocity*. The scanning velocity of the information is 10 to 25 times greater than is possible with the best tape drives.
2. *Continuous scanning within a page*. Normally a problem requires repeated access to the same location. For example, when an inventory is updated, we first want to know what is in stock, and then return the answer to the same location on the tape. With a tape device we would have to allow for the start, stop, and reversal time to return to that same location.

These features make the TapeDRUM particularly practical for applications involving few and noniterative computations or for straight data-processing applications where the information can be sectionalized.

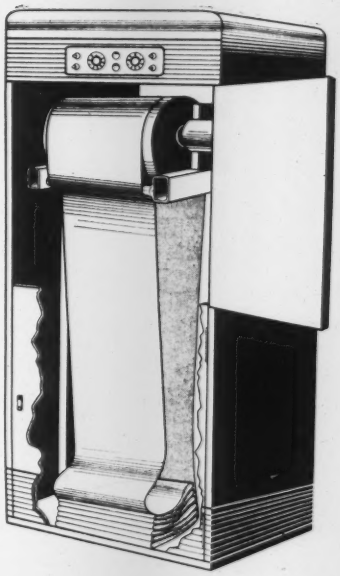

Fig. 4. 200,000 binary digits can be stored on one "page" (section of tape being scanned); many pages can be used to extend storage capacity to 100,000,000 bits of information or more.

Quasi-Random Access

It can be seen from the above specifications that the TapeDRUM has actually two levels of access time:

1. The access within a page.
2. The access to any page in the tape.

The second access time depends on the total length of tape used.

If the TapeDRUM were used strictly as a random-access memory, the average access time would be high because the probability is small that two items are going to be on the same page. On studying many applications it was found that one can usually permit a longer access time to any one memory location, provided that it appears to the input *as if* the access time were shorter. Thus, the term *Quasi-Random Access* has been coined for configurations useful for many business systems.

Savings Bank Example

Let us illustrate a quasi-random-access system with a simple example. A savings bank wants to maintain records on 30,000 accounts. Each account requires about 700 decimal digits of information to store the detailed deposits and withdrawals and significant information concerning the depositor. Ten deposits or withdrawals must be entered into the memory every minute. These entries come from various tellers in a random sequence.

The above requirements call for a storage of 21,000,000 decimal digits, or approximately 500 pages on the TapeDRUM. The average access time to any one of these 500 pages is about 25 seconds. Of course, this access time can be decreased by using eight TapeDRUMs so that each of them has only 60 pages. In that case the maximum access time to any item on one TapeDRUM is less than 6 seconds. Furthermore, the probability that all entries will call for the same TapeDRUM is small, so that we can actually tolerate somewhat longer access times than 6 seconds.

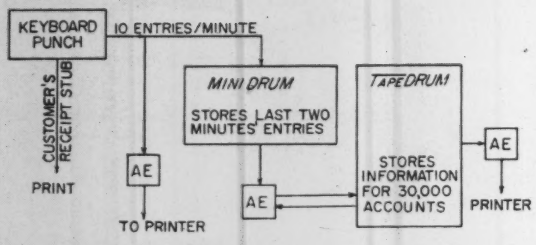

Fig. 5. Accounting system for a savings bank can handle 30,000 accounts, at the rate of 10 transactions per minute. Buffer drum (MiniDRUM) stores each transaction until TapeDRUM is in position to receive the data. (AE units are arithmetic elements.)

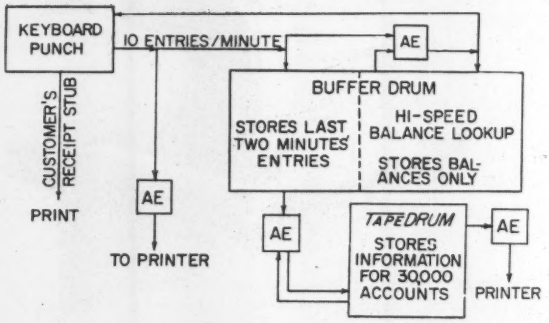

Fig. 6. Addition of high-speed balance lookup to bank accounting system so that the balance in each account can be available to each teller.

According to the above calculation it appears as if eight TapeDRUMs are needed to satisfy the entry rate requirements. Actually, only a quasi-random access time of 6 seconds is needed; our only requirement is that we maintain an entry rate of 10 transactions per minute. Fig. 5 shows how this can be done. Instead of entering all transactions directly into the TapeDRUM, an intermediate buffer drum stores the entire transaction until the TapeDRUM has moved to the proper position. The buffer storage can be a conventional inexpensive drum. The required space in the buffer storage is:

$$\textit{Buffer storage} = (\textit{digits/entry})\ (\textit{entries/sec})\ (\textit{time for tape to go around}) \quad (1)$$

The time (T) for tape to go around is on the average:

$$T = (\textit{no. of pages})/(\textit{page advance rate in pages/sec}) + (\textit{time to stop}) + (\textit{no. of stops}) + (\textit{time to enter on drum})\,(\textit{no. of entries}) \quad (2)$$

For the TapeDRUM specifications cited:

$$T = 0.2\ (\textit{no. of pages}) + 0.25\ (\textit{no. of stops}) + 0.1\ (\textit{no. of entries}) \quad (3)$$

By solving Equation 1 and Equation 3 simultaneously, Equation 3 reduces for this example to:

$$T = 100 + 4 + 2 = 106 \text{ sec.} \quad (4)$$

How does a quasi-random system work? Every entry is originally stored in the buffer drum. The TapeDRUM does not attempt to move randomly to the storage location of the next item. Instead, the TapeDRUM cycles from one page to the next in steps. At every page the tape determines if there are one or more items in the buffer drum for the TapeDRUM. These items are then processed at a rate determined by the drum velocity. For the specifications listed, a transaction can be entered every 0.1 sec.

By use of this quasi-random-access approach, a system that had originally required eight TapeDRUMs has now been reduced to a conventional drum and a single TapeDRUM, a considerable saving in price and complexity.

Let us compare this system to a conventional tape system. Only items that are actually being modified are routed through the arithmetic element. An item is updated in the same location where it was originally. Thus, no operator is needed to move tape reels. Furthermore, once an item is in the main store, it stays in that location without any further electronic operation on it.

As we perform only 20 to 30 mathematical computations per minute, arithmetic elements can be slow and inexpensive.

This savings-bank example shows that the quasi-random-access approach yields the following features:

1. A single master memory with longer access time is satisfactory.
2. Lower speed arithmetic elements can be used.
3. No sorting in the conventional sense is required.

The quasi-random approach described has certain drawbacks. If we had provided a true random-access time of 6 seconds, the teller could have obtained an output from the store as well as putting information into it. The quasi-random-access approach described assures only that information can flow *into* the main store, but no information can flow back until after the main store has come to the proper location, which can take as long as 2 minutes.

Adding a Running Balance

The following describes how the quasi-random access system can be modified to yield information flow back to the teller. For example, if on a withdrawal the teller had to know whether the customer has sufficient funds on deposit to cover the withdrawal, and that this information be supplied to the teller, the following quasi-random access system could be used. While approximately 750 digits of information are stored in the main store to list in detail every transaction, true random access is needed for only the balance, which may amount to 10 digits per account. Ten to twenty digits per account amount to approximately 500,000 decimal digits of information, which can be stored on a standard drum.

Fig. 6 shows how this is accomplished. As the buffer drum requires few digits in this application, the drum containing the buffer and the balances would actually be combined. In Fig. 6 both the TapeDRUM and the balance drum must be updated by each transaction.

In this example the quasi-random approach satisfies the requirements of the application for access time and storage capacity. The combined system still only requires two drums in place of the eight required for completely random access.

References

1. S. J. Begun, "Magnetic Memory Device for Business Machines," *Electrical Engineering*, Vol. 74, June 1955, pages 466-68.

2. G. H. Hollander, Digital Data Recorder, Technical Memorandum 6897-TM-12, MIT, Servomechanism Lab, Cambridge, Mass., Oct., 1953.

Digital-to-Analog Conversion

Weighting is the technique used to convert digital signals into analog form. A mechanical and an electronic digital-to-analog converter are described, plus a complete multiplexed digital system with analog input and analog output.

MARTIN L. KLEIN, FRANK K. WILLIAMS and **HARRY C. MORGAN**
Rocketdyne Div., North American Aviation, Inc.

Weighting for Digital-to-Analog Conversion

Our discussion to date has included methods for multiplexing several inputs (analog or digital) to provide a time-shared output, and methods for clamping the analog signal while digital conversion is being made. It is often desirable to reconstruct an analog signal from the train of pulses which represent the digital presentation of the data.

Suppose the analog signal shown in Fig. 7-1 is quantized (represented by a group of pulses) and the digitizing is done at fixed intervals. The pulses representing the analog signal at the fixed intervals shown are the digital presentation of the data as might be obtained from an analog-digital converting device. Suppose it is desired to take these pulses and reconstruct the original analog signal.

As the readings are made at fixed intervals, and as we are not examining the analog trace between these intervals, we can only reconstruct the analog signal at the times at which the conversion was made. We have no exact information as to what happened *between* the times at which the conversion is made. This is entirely analogous to the familiar technique for drawing a curve through points plotted on a graph. We have no information about the analog trace between any two readings; all we can do is to plot the data points obtained and connect the points by straight (or curved) lines. Electronically, we do essentially this same thing, using straight lines.

It is first necessary to recognize that the various pulses representing bits actually represent different voltages. That is, if the binary code for an analog value of 7 volts is 111 (pulse, pulse, pulse) the leftmost 1 (or pulse) represents 4 volts. The second or middle 1 (or pulse) represents 2 volts, and the last 1 (or pulse) represents 1 volt. Similarly the binary code 011 (no pulse, pulse, pulse) actually represents 3 volts. Obviously, if we are to go from a pulse code to an analog point, we merely need to add the appropriate voltages for which the binary code stands.

In Fig. 7-2 we have three batteries feeding a summing network; each battery is connected through a switch. One battery is 1 volt; the second is 2 volts; the third, 4 volts. Now let us convert the pulse code 001 into an analog point. We arrange the pulses to actuate the appropriate switch. For example, the least significant bit (1) is connected to the switch on the 1-volt battery; the second bit to the 2-volt battery switch; the third bit to the 4-volt battery switch. When the 001

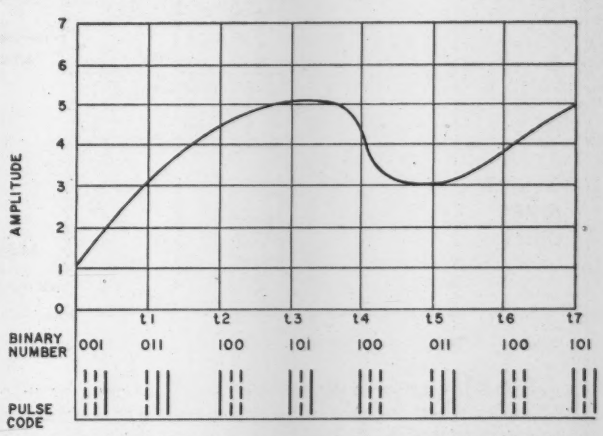

Fig. 7-1. Analog signal (curve) can be represented at intervals by binary pulse code, as shown. Value at each interval (t_1, t_2, etc.) is given to the nearest whole number.

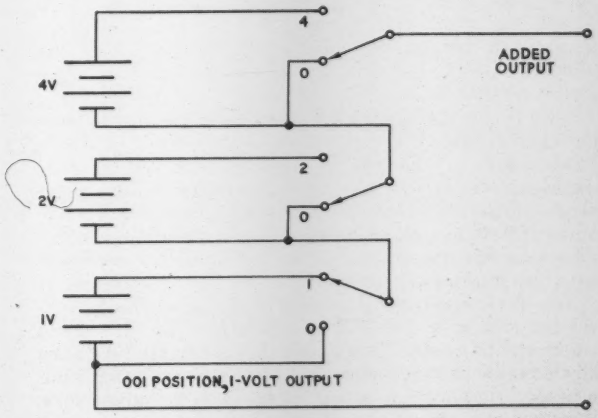

Fig. 7-2. Simple relay circuit for adding binary voltages (1, 2, 4, etc. volts) to produce an analog voltage output. The three relays shown would be in the positions shown upon receipt of digital signal 001, producing an output analog voltage of 1 volt. A binary input of 111 would operate the switches to the upper position and produce an output of 7 volts.

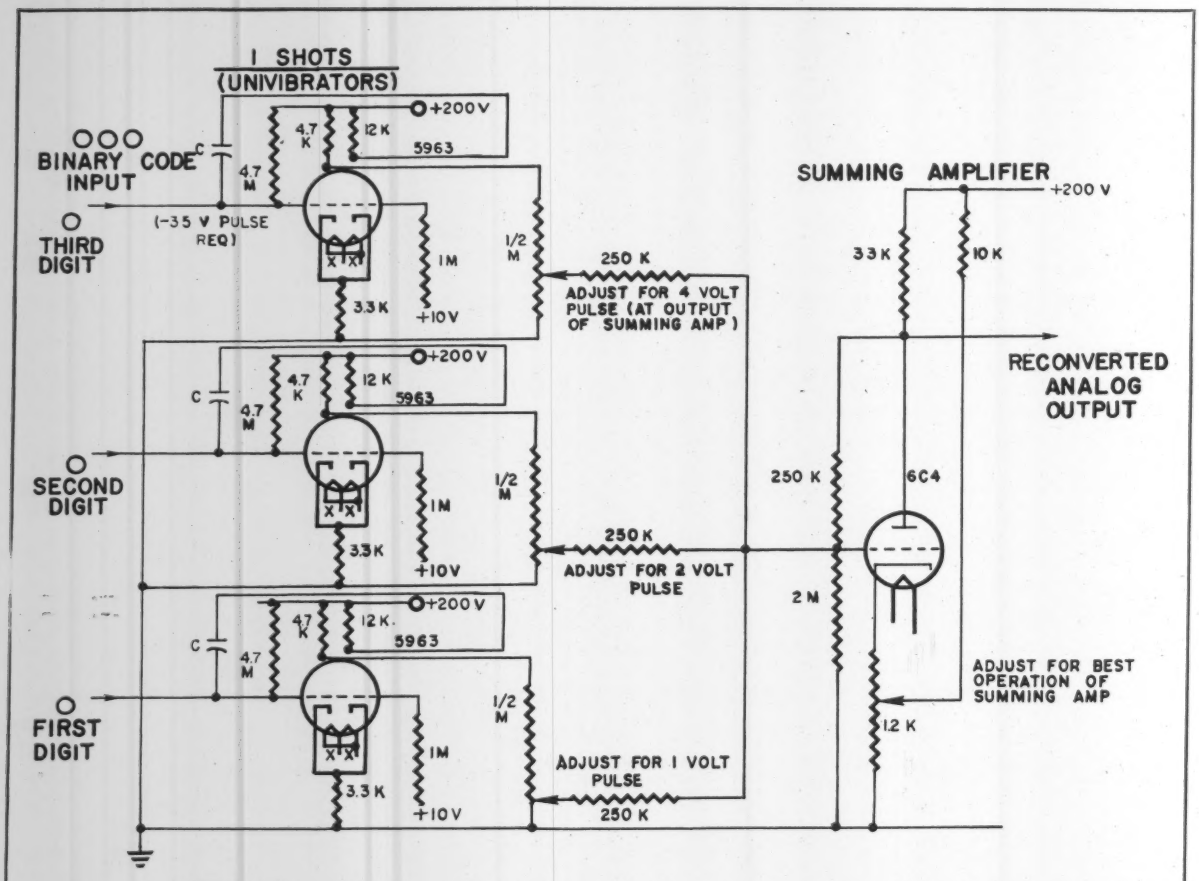

Fig. 7-3. Electronic digital-to-analog converter, or reconverter. Gate tubes (Types 5963) supply 1, 2, or 4 volts to adder when negative input pulse permits tube to operate. Hence 3 inputs, representing binary number 111, result in output of 4 + 2 + 1, or 7 volts—the analog of binary 111.

pulse code arrives, only the 1-volt battery switch is closed, the other two pulses being absent. The result is a 1-volt output. If pulse code 101 is fed to the switches, the 1-volt and 4-volt battery switches close and the result is a 5-volt output.

This is the basic principle for reconstructing of analog points from the pulse code representation. If the pulse code for the analog trace of Fig. 7-1 is converted by this scheme, we reconstruct the analog points at the points at which the digitation occurred. We are not entitled to information between these points because we did not digitize these points and accordingly have no information about it.

The electromechanical scheme of digital-to-analog conversion shown in Fig. 7-2 is satisfactory for slow-speed reconversion where relays can be used. However, an all-electronic arrangement in which the weighting voltages are supplied by gating tubes is more satisfactory. This method allows the reconversion of pulse codes at speeds up to one million pulse codes per second. In practice, the reconversion limit at present is about 100,000 conversions per second.

Electronic Digital-to-Analog Reconverters

A typical all-electronic circuit to accomplish reconversions from pulse code representation to analog points is shown in Fig. 7-3. Gating tubes of the twin-triode type are used to supply fixed voltages from a standard voltage source and voltage dividers. The gates (Types 5963) open or remain closed according to the presence or absence of a code pulse, as with switches in Fig. 7-2. The voltage outputs are added to obtain a single pulse whose height is the analog point represented by the pulse code of the voltage. Note that the pulse code is a train of pulses of equal height. The reconverter combines the pulses into a single pulse whose height is an analog of the original analog trace. For example, a pulse train 111 (that is, a pulse into each of the 3 gates in Fig. 7-3) would result in a 7-volt output pulse. Up to the reconversion the system is independent of pulse height and depends only on the presence or absence of a pulse. After the reconversion is made, the pulse height is the critical value which must be preserved.

Combining Elements

Suppose we wish to obtain the reconverted analog signals from a multiplex input. Let us say, as in Fig. 7-4, that we have four inputs which are multiplexed at high speed. These four inputs are then clamped, as has been described, and converted to a digital representation in pulse code. We now wish to separate these

pulses and obtain the analog signals which were inserted to the multiplexer by the four separate lines.

The use of four separate output lines, as in Fig. 7-4, requires that the multiplexer run in step with a demultiplexer to sort the separate inputs. Before we arrive at the demultiplexer, we first put the pulses through a weighting network similar to the one described. We now have pulses of variable height coming one after another. The first pulse might represent the input of Channel 1, the second of Channel 2, and so on—but the pulse heights will be different after weighting and represent the analog voltage at the time at which the clamp was made. We now pass these pulses of different heights through the demultiplexer, which is running in step with the multiplexer. These pulses are then sorted, or placed on the appropriate output lines. We now have the analog points separated, each channel coming out on a separate line.

By suitable filters on the outputs, we could connect these points so that we see only the height of the pulses and not the separate pulses, and thus essentially reconstruct the input analog signals. An alternate device, as used in Fig. 7-4, makes use of a clamp on the output of each line. This clamp holds the pulse height until the next pulse is received; it then takes the next pulse height value and holds that value. The analog signal is then reconstructed from a series of plateaus, as in Fig. 7-5. A simple integrating circuit using a feedback capacitor between the plate and grid smooths these plateaus into a more or less continous curve. Again, we are reconstructing the analog curve without knowing what has actually happened between the points at which the conversion is made. Therefore, as shown in Fig. 7-6, the smoothed curve obtained is not the correct representation of the actual analog input *except* at the times at which the conversion is made. This again depends upon the conversion rate; Information Theory tells how much information is retained and how much is lost.

A simple example of the practical use of such a scheme is for telephonic conversations. Four separate conversations could be carried on simultaneously on a single wire and the conversations separated and restored at the end of the line. It is generally acknowledged and has been proved that the effect of spurious noise is eliminated by transmitting information in pulse-code form.

Instead of a wire, a single r-f carrier could transmit the four conversations. Moreover, with pulse coding, background noise in airborne signal transmission is largely eliminated, and transmission in the presence of interfering signals is possible.

In instrumentation work, the use of pulse-code modulation (pcm) eliminates the many problems attendant with transmitting data long distances on cables. Also. the analog signal can be reproduced at the end of the transmission.

In automation (as will be shown later) digitizing of the analog signal is often the most expeditious way way of handling automatic control situations. The digitized signal allows the coding and programming of automatic digital computers and logical networks. It is often desired to obtain, for monitoring purposes, an analog record of the information being used by the controller or the output of the transducer. The circuitry shown permits the on-line reproduction of the transducer output.

In another circuit that will be described, this analog signal is compared with the input to check the converter. That is, since the reconstructed analog signal involves the whole system—multiplexer, clamp, converter, reconverter, demultiplexer—we have a positive check on the whole system. If we take this reconstructed analog signal and compare it electronically with the input signal to the converter and obtain the same values, it is probable that the entire circuit has properly converted the input analog signal for the control computer. This serves as low-order checking of the entire circuit. We can also arrange to reject, electronically, conversions which are in error to the extent that the reconstructed analog signal and the input analog signal do not agree.

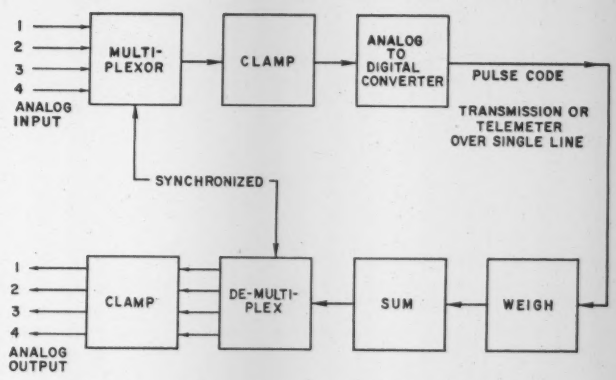

Fig. 7-4. Complete system for receiving several analog channels, multiplexing, converting to digital form, telemetering, and then reconverting to separate analog signals.

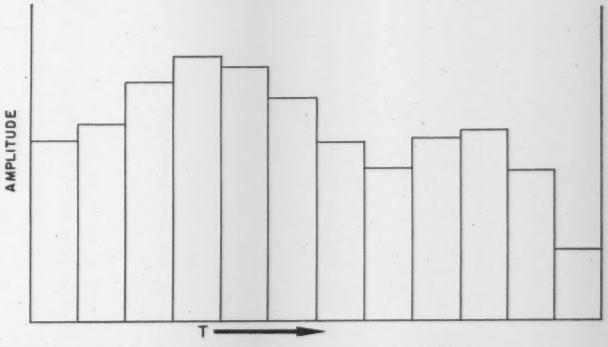

Fig. 7-5. Output clamp of Fig. 7-4 would deliver signal of this type (series of plateaus) to each of the output analog channels shown in Fig. 7-4.

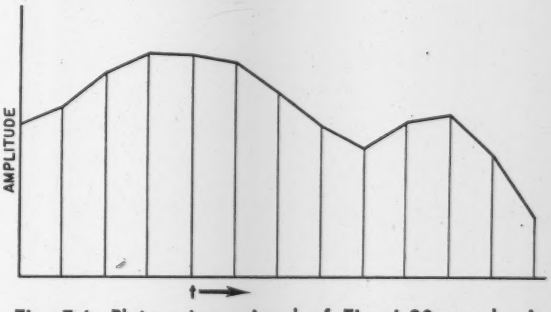

Fig. 7-6. Plateau-type signal of Fig. 6-20 can be integrated and smoothed by simple integrating circuit using a capacitor.

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Foster Engineering Company

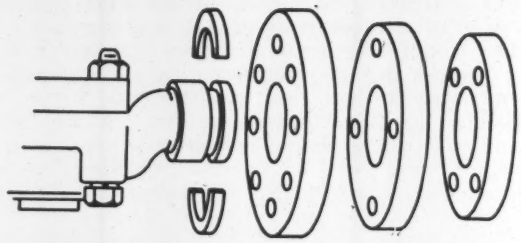


Fig. 4-1. Flanges of different ratings may be used with a basic body in this design.

Mechanical Features

Mechanical features of valve bodies must be considered by the engineer selecting a valve for his job. These features include end connections, body design, guides, seats, stem connection, packing gland, seals and radiators.

End Connections

END connections to the valve body are usually screwed, flanged or welded. Selection of the end connections will follow closely the piping standards for the installation.

Face-to-face dimensions of *flanged* valves have been standardized by most manufacturers to be the same as those of line valves* of the same pressure rating (Table 4-1). This standardization has been accomplished through the cooperation of the Instrument Society of America and the Steam Specialties Club, and makes replacements and repairs possible without complicated fitting changes.

One company has designed a flange assembly with a split retainer ring to facilitate changing of flanges. As the body is designed for 60 ASA rating,** the 15-, 30-, or 60-series flanges may be used with the same body. The assembly and the manner of holding the split ring are shown in Fig. 4-1.

Use of *weld-end* valves is becoming prevalent, particularly in high-pressure gas-metering stations. In this case, valve and swaged nipples form a spool piece.

Screwed-end valves are used up to and including the 2″ size unless unusual temperature or high-pressure conditions require flanges.

Ring-joint and *tongue-and-groove flanges* are installed only on elevated temperatures and pressures. Many small size valves are furnished with *union connections.*

Body Design

Design of the body of a valve for the pressure and service for which it is to be used is the responsibility of the manufacturer. Certain designs allow the valve to be much lighter than others, a quality that should be popular with field men. The porting of the discharge side of the plug and seat should be large enough and so shaped that it does not contribute to the pressure drop across the valve. For best control, the pressure drop should be across the variable restriction of the valve.

The materials used in the body and trim must be selected carefully and on the basis of specifications.

The most common body materials are (1) iron, (2)

Table 4-1.—Uniform Face-to-Face Dimensions for Flanged Control-Valve Bodies

Pipe Size (Inches)	125-PSI Iron 150-PSI Steel (See Note 1)	250-PSI Iron 300-PSI Steel (See Note 2)	600-PSI Steel (See Note 3)
½	***	7½	8
¾	***	7⅝	8⅛
1	7¼	7¾	8¼
1½	8¾	9¼	9⅞
2	10	10½	11¼
2½	10⅞	11½	12¼
3	11¾	12½	13¼
4	13⅞	14½	15½
6	17¾	18⅝	20
8	21⅜	22⅜	24

Note 1—Cast-iron bodies with 125-PSI ASA B16A-1939 flanges, and steel bodies with 150-PSI raised face ASA-B16E flanges.
Note 2—Cast-iron bodies with 250-PSI ASA B16B-1944 flanges, and steel bodies with 300-PSI raised-face B16E-1939 flanges.
Note 3—Steel bodies with 600-PSI raised-face ASA B16E-1939 flanges.

* The term "line valve" is commonly used for conventional hand-operated valves, as contrasted with automatic control valves.
** The 600-psi ASA rating is often referred to as "60 ASA"; similarly the 150-psi ASA rating is called 15 ASA, etc.

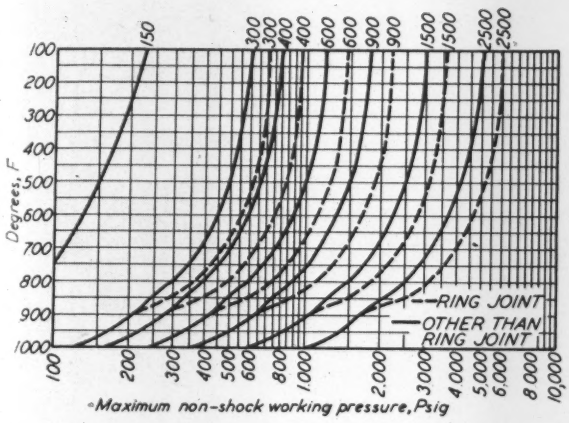


Fig. 4-2. Carbon-steel valve bodies must be selected with consideration for temperature and pressure.

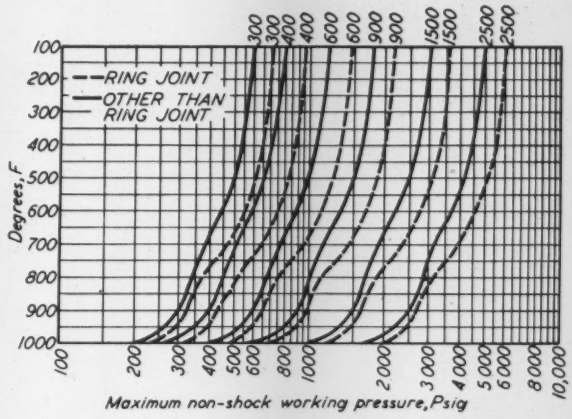


Fig. 4-3. Alloy steel allows use of body for greater pressure when temperature is above 800-900° F.

steel, (3) bronze, (4) red brass, (5) Monel metal, (6) nickel, and (7) aluminum.

Temperature-pressure ratings are shown in Fig. 4-2 for carbon-steel bodies, and in Fig. 4-3 for alloy steel.

There is a strong trend to use of steel bodies (carbon, alloy, and stainless) for hydrocarbons and steam at all temperatures and pressures. Stainless-steel trim is being used in many cases to combat erosion; however, the cost of stainless-steel bodies must be considered.

Most water service calls for bronze or iron bodies and brass trim.

Difficult chemical services require bodies of special metals, plastics, or ceramic, with rubber, plastic or ceramic lining. The choice of body material requires careful consideration of many factors, including the corrosion factor where liquid changes to vapor and vice-versa, sparking effect at seats, code considerations, etc.

Although most valves have been developed to minimize erosion, every effort should be made to foresee possible excessive erosion. This can occur when vapors contain globules of water, when supposedly clean natural gas picks up sand from the pipeline, or when contaminated condensate creates an acid condition that contributes to erosion as well as corrosion. Stelliting or other hard surfacing on the seats may be necessary unless care is exercised to select a special valve for the service. Valve seats can be surface hardened by various methods or hardened throughout.

Easy access to the seat and plug is essential. Most valves have replaceable seats, although extreme vibration (such as encountered in marine service) may require integral seats or welding of the seats. The removable seat is a desirable feature, but requires working inside the valve for replacement. Such an operation is facilitated by a removable top, bottom, or side flange (Fig. 4-4).

Unless a valve is designed for one service alone, it should be reversible. In process instrumentation, it is sometimes difficult to determine whether a particular application requires a valve that is normally closed (that is, to close on air failure) or normally open. Fig. 4-5 shows the various possibilities when the valve is used with a controller. Note that the valve can be opened or closed by an increase of pressure applied to the diaphragm, and that the valve can be made to open or close on air failure. The pressure applied to the dia-

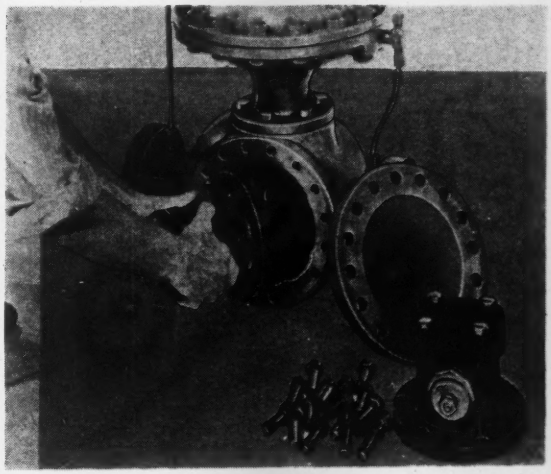


Fig. 4-4. Access to main valve and seat is essential. This may be accomplished with removal of top, bottom, or side flanges.

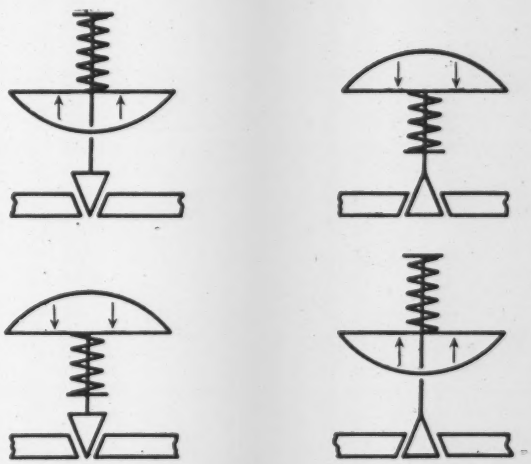


Fig. 4-5. Main valve must be reversible to meet possible variations of valve design, depending on controller action.

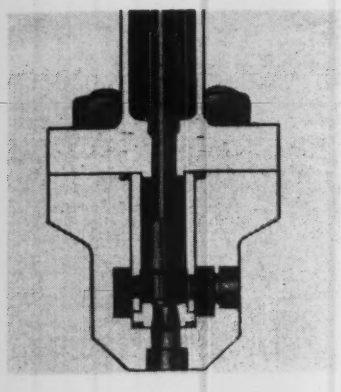


Fig. 4-6. Replaceable guide makes it possible to correctly position the bonnet as well as the guide itself. The guide holds down a replaceable seat.

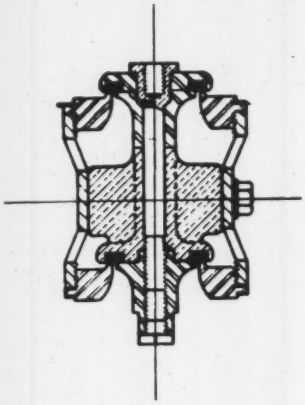


Fig. 4-7. Valve cage assembly includes three components: plugs, seats, and guide.

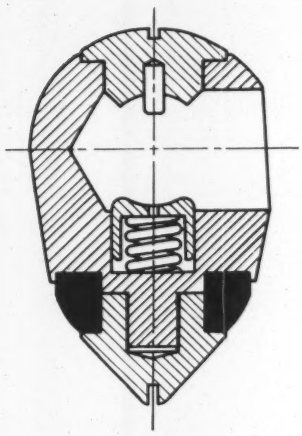


Fig. 4-8. Soft seating surface (rubber) adapted to a streamlined inner main valve.

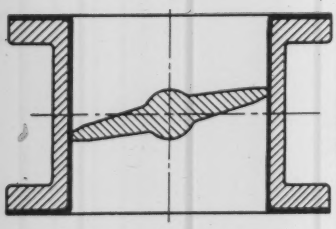


Fig. 4-9. Rubber lining of butterfly valve gives tight shut-off.

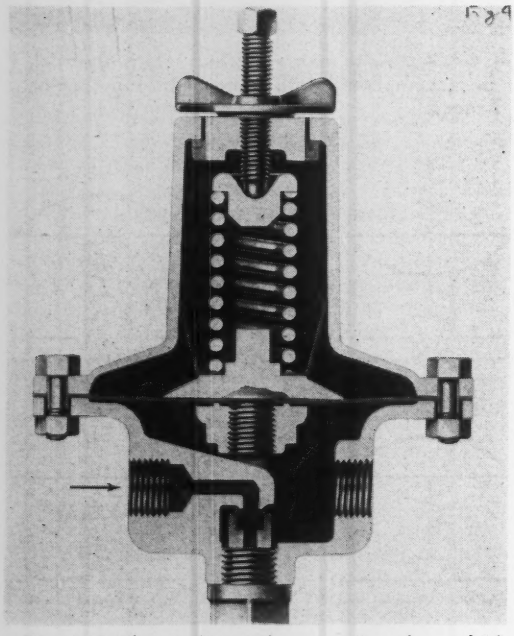


Fig. 4-10. Flow is directed upon soft surface which is easily replaced.

phragm will, of course, depend on the controller used to control the process variables.

Guides

Proper seating of the plug on the seat requires a positive and unchanging relation between the plug and the seat. This is accomplished by *guiding*.

Wing guides on the main valve may be used for quick-opening valves; a *skirt* is used as the guide in various forms of V-ported plugs. The close tolerances necessary for guiding control valves properly cause sticking under conditions of wide temperature changes, heavy fluids, foreign matter, or when the plug becomes cocked in relation to the seat. To eliminate cocking, a form of ball-and-socket joint has been used to allow the plug to position itself.

Necessity for wide rangeability in process control requires accurate guiding to obtain the low flow rate when the main valve is just off its seat. In this position the flow is essentially through an annular space between the inner wall of the seat and the outer surface of the main valve. A very small annular space (approximately 0.008″ for a small 2½″ valve) will pass the few gallons per minute, as required. Any misalignment of the main valve will distort the flow and cause the main valve to bind. The control valve of the globe type, which accomplishes rangeabilities of 30 to 1 or more, must be top and bottom guided.

Many specifications require a difference of at least 125 Brinnel numbers between the material of the main valve and that of the seats and the guide surface. In most cases seats and guides are hardened.

The design shown in Fig. 4-6 allows accurate alignment of seats and guide, and serves as a guide for the bonnet. Most guide designs provide a sufficient opening to allow a flushing action around the guide, particularly for the bottom guide of a double-seated valve.

A *valve cage* comprises plug, seat and guide (Fig. 4-7). Proper seating of the plugs on the seats is obtained by shimming the bottom seat.

Seats

Metal-to-metal contact of inner valves and seats can be accepted for services where complete shut-off (or lock-up) is not necessary. Double-seated valves have the

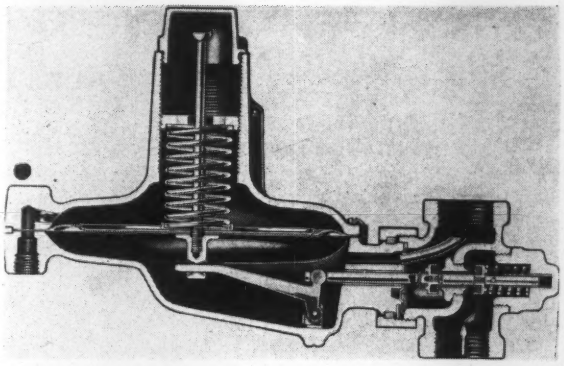


Fig. 4-11. Gas regulator for domestic use employs soft disc for positive lock-up.

inherent difficulty that the seating surfaces do not remain uniform and, therefore, the valve leaks after being in service. All manufacturers of valves strive to furnish tight closing valves, but few valves can remain leakfree after continual use. Although use of hard metal increases the period of low leakage, consideration must be given to the question of whether a probable six-percent leakage in the closed position will be detrimental or dangerous to the process.

The single-seated valve gives much better shut-off over a much longer period. However, use of the single-seated valve has been confined to small sizes and low pressure-drops because the unbalanced forces become excessive in larger sizes. More consideration is now being given to their use, with piston motors and springless diaphragm motors being used for positioning the valve.

Necessity for complete lock-up requires a soft seating surface. One method is use of a rubber, leather, or composition disc to contact a metal seat. Fig. 4-8 shows the soft surface as part of a streamlined plug. Valves using a rubber sleeve or rubber diaphragm for closure give tight shut-off. Fig. 4-9 shows use of a rubber insert to obtain tight closure in a butterfly valve.

The soft seat of Fig. 4-10 is typical of a large group of regulators, particularly in water service. The flow is directed down upon the disc, which is carried on a cage that moves with the diaphragm. The disc or seal shell is guided by a spring. A similar type of regulator (Fig. 4-11) is applied for reducing gas pressure for domestic service because it must give absolute lock-up.

Stem Connections

Difficulties with taking apart the main valve and the stem, and in separating the upper and lower portions of two-part stems, have directed attention of the designers to these connections. Although a ball-and-socket joint would help the main valve seat itself on the seat, alignment requirements preclude this method of connecting the two parts. Various solutions have been found, of which pinning the stem after screwing it into the main valve is most common.

A unique design (Fig. 4-12) accomplishes a 2:1 travel ratio between lower and upper stem by a pinion and rack connection of the two parts. The resulting advantage is rapid closing of the valve.

Packing Glands

Inasmuch as the operating device (diaphragm or electric motor) must, in most valves, pass through a yoke

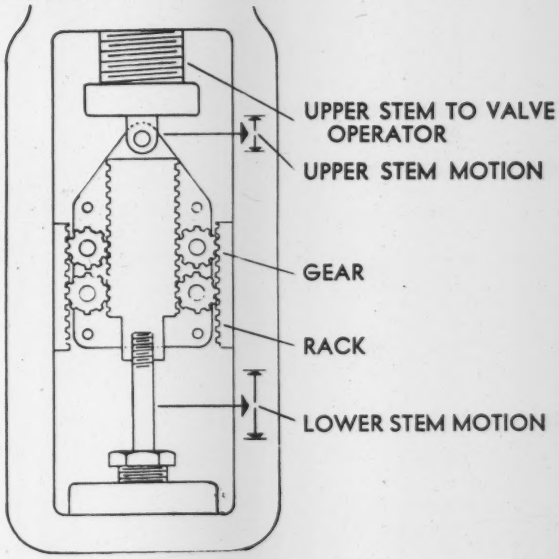


Fig. 4-12. Lower stem movement is twice upper stem movement in this ingenious stem connection.

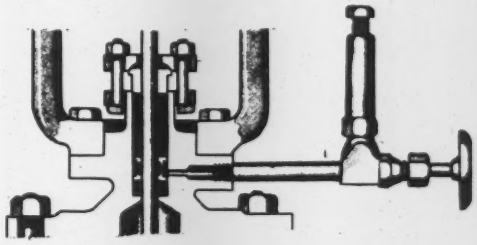


Fig. 4-13. Lantern ring is placed between molded packing for lubricant injection.

to the body of the valve, some type of packing gland is necessary. This unpretentious portion of the valve can cause the failure of the entire control system.

Successful functioning of the control valve requires free movement of the stem (in contrast, the hand valve can be forced into position). Low hysteresis requirements demand little friction between stem and packing, yet sufficient contact must exist to prevent leakage.

Four methods of sealing are common: (1) Prefabricated composition rings, separated by a lantern ring for injection of a lubricant seal; (2) prefabricated Teflon rings; (3) metal bellows; (4) diaphragm.

Standard Packing with Lubricant

Prefabricated rings composed mainly of graphited asbestos have replaced the string packing widely used in hand valves. Two or three rings placed at the bottom of the stuffing box (Fig. 4-13) are followed by a lantern ring and additional rings in the upper portion of the packing gland. The lantern ring is a metal spacer which allows the lubricant to be injected through the port to fill the space between the packing rings, forming a seal against the line fluid. The lubricant thus becomes a more vital factor in the packing system than the rings themselves. In this system the packing-gland follower should not exert as much pressure as to cause the rings to bind the stem. The gland nut or bolted

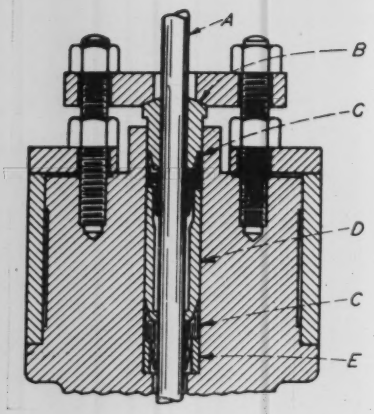


Fig. 4-14. This Teflon seal is designed to operate at high pressures.

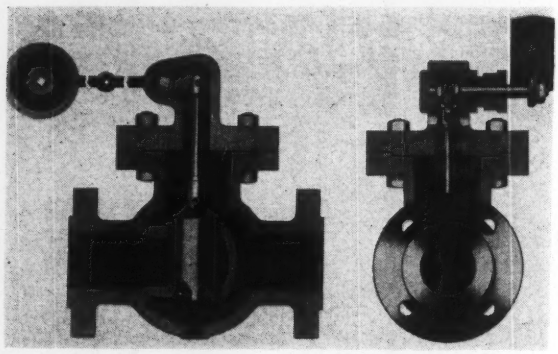


Fig. 4-15. Rotating stem reduces friction caused by packing.

flange should successfully stop leakage when only finger-tight.

Proper selection of lubricant is important. Sealing lubricant must have the following characteristics: It must be greasy in order to lubricate; it must be able to spread and maintain a continuous film which is not broken by the movement of the stem or the force caused by the line fluid; the lubricant must resist the line fluid physically and chemically; it must be insoluble in the flowing medium (for mutual protection); it must resist deterioration; it must maintain its properties under operating temperature.

The lubricant is injected into the lantern ring by use of a lubricator (Fig. 4-13). Valve lubricants usually are furnished as sticks for easy insertion into the lubricator. The stick is placed in the barrel of the lubricator and forced through the passage with the screw. An isolating valve is used in valves on high pressures, elevated temperatures, or on corrosive or dangerous fluids. (A pressure of 150 psig and a temperature of 250 degrees F are arbitrarily selected as points above which the isolating valve is recommended.) Table 4-2 is useful in the selection of lubricants.

Teflon

Teflon (tetrafluor-ethylene resin plastic) has been accepted by many valve manufacturers for valve packing. Teflon has numerous advantages; its outstanding property is inertness to chemicals. It shows little physical change in service from minus 300 to plus 700° F, except for expansion. It has self-lubricating qualities, may be used in molded or machined shapes, and is tough.

Teflon is used as a packing in various forms:

(1) Pre-formed rings. Solid Teflon is shaped in different ways much like asbestos rings.

(2) Spacer rings. Standard packing may be separated by thin Teflon sashers. The sealing action in this method is accomplished by the packing rings, thus limiting advantages to the characteristics of the packing used. A patented Teflon seal is shown in Fig. 4-14. The assembly consists of a smoothly finished plug stem (A), gland follower (B), plastic seat, gland, plastic seal, and lower gland. The seal is claimed to be operative to as high as 27,000 psig.

(3) A patented loose shredded Teflon between Teflon washers. This method offers successful sealing and low friction but is not convenient for servicing and requires variable adjustments during operation.

(4) Molded graphited shredded Teflon with Teflon spacers. This method offers the advantages of Teflon and the lubricating qualities of graphite, but is limited by the ability of the binder to withstand the flowing fluid.

(5) Woven asbestos-base Teflon-impregnated rings.

Table 4-2.—Typical Valve Lubricant Selection Chart

Lubricant*	Temp. Range (°F) From	To	Recommended Service	Unsuitable For
Group A	20	125	Acids, alkalies, chlorine aqueous solutions, foodstuffs and alcohol.	Petroleum and coal tar solvents.
Group B	50	400	Steam, hot water, hot caustic, ammonia, alcohol, glycerine, dilute mineral acids, animal and vegetable oils.	Strong mineral acids, gasoline, kerosene, benzol and mineral oils.
Group C	0	175	Gasoline, kerosene, naphtha and mineral oils.	Aqueous solutions of all kinds, steam, alcohol and acids.
Group D	40	250	Hot sulfuric acid, oleum, non-oxidizing chemicals.	Hot nitrating acids, hydrocarbon solvents.
Group E	5	150	Natural and manufactured gas where water organic condensates are present.	Strong acids and solvents.
Group F	50	500	Hot mineral oils, phenol or cresylic acid with mineral oils.	Strong mineral acids, chlorine, or reactive chemicals.
Group G	50	750	Mineral oils and hydrocarbon vapors at high temperatures.	Acids, strong chemicals and strong organic solvents, and benzol.
Group H	40	300	All hydrocarbon solvents, carbon bisulphide, foodstuffs, and carbonated beverages.	Strong acids, alcohol, aqueous solutions. Do not use on nitrating or mixed acids.

*Valve and lubricant manufacturers can supply specific lubricants in each of these major groups.

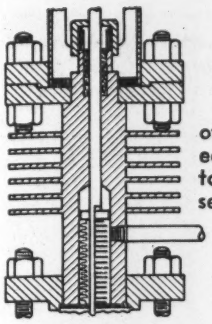


Fig. 4-16. Top of bellows is welded to stem, bottom is welded to seal.

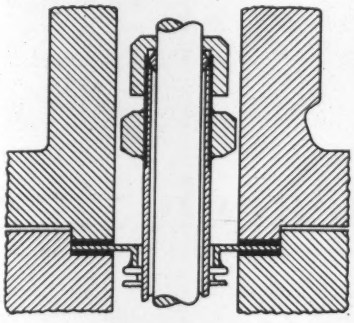


Fig. 4-17. Guide is sealed to stem with a compression ferrule and lock nut, while bottom of bellows is welded to sleeve.

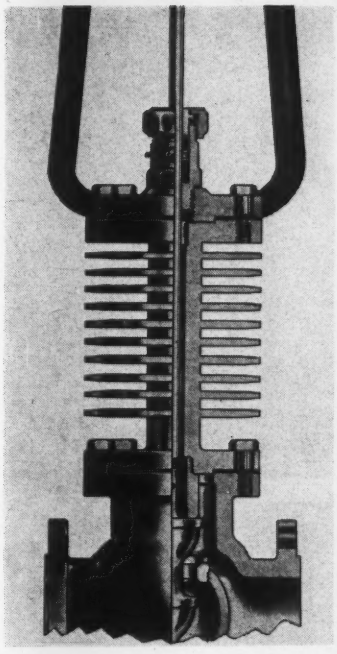


Fig. 4-18. Cooling fins are needed when fluid temperature is above 450° F.

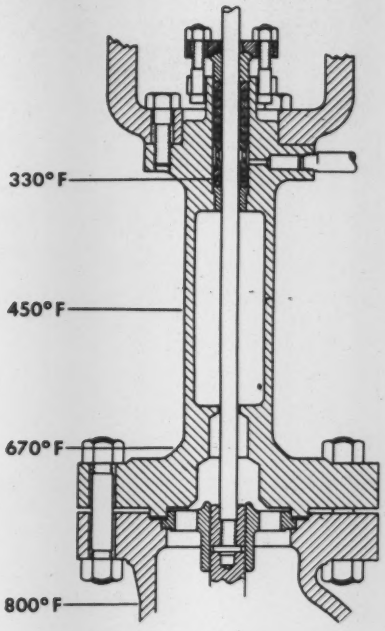


Fig. 4-19. Radiation from a black surface is combined with the low conductivity of stainless steel to cause reduction of heat transfer to packing in this thermal-isolating bonnet.

Seals

Many body designs, particularly for pressure-regulating valves (Fig. 4-10 or Fig. 4-11) need no packing because the line pressure is exerted directly upon the actuating diaphragm. The limited travel obtainable with a flat diaphragm does not allow its being substituted for packing in valves that require long travel. Long travel, however, can be obtained with a patented diaphragm, made of nylon impregnated with Buna-S rubber, and molded with narrow convolutions. The convolutions roll and unroll with the travel of the stem. Applications are limited only by temperature and chemical effects upon the material.

Piston-operated valves, or single-seated valves using a piston for balancing, must have a seal between the high- and low-pressure sides. This is accomplished with metal or fiber rings, O-rings or leather cups. O-rings of various shapes offer low friction to piston movement. Selection of the seal must be made on the basis of temperature, pressure and fluid characteristics. It is best to follow the recommendations of the equipment manufacturer.

Frictional effects of packing are much less when the stem is rotated than when its motion is purely reciprocating. Advantage is taken of this in the design of valve bodies (Fig. 4-15). This method is used frequently in valves operated by a float or other actuator when the force available to position the valve is small. The stem can be lifted by a lever arm or positioned by a gear on a shaft acting on a gear train on the stem.

Bellows Seals

Steel bellows have made possible a packless valve, as shown in Figs. 4-16 and 4-17. The top of the bellows is welded to a flange, which seals the line fluid within the body. In Fig. 4-17, a guide is sealed to the stem with a compression ferrule and locknut. With the bottom of the linear guide welded to the bellows, and the top of the bellows welded to a flange, the line fluid is confined within the body.

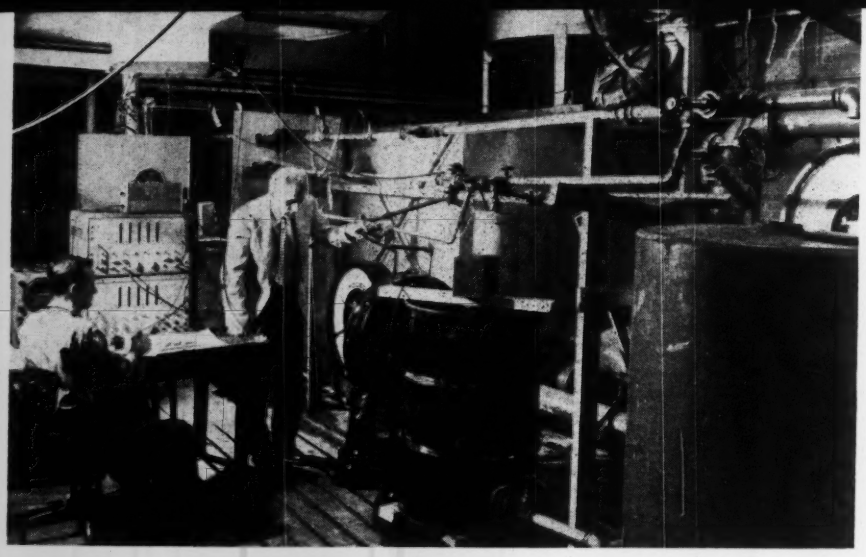
Packless sealing is accomplished by welding the bottom of the bellows to an internal guide, which in turn is welded to an external chamber. The chamber is seated on sealing packing at the bottom. In this design the bellows tube collar acts as a safety stop. A hexagonal guide through a bushing eliminates bellows rotation.

Cooling and Heating Sections

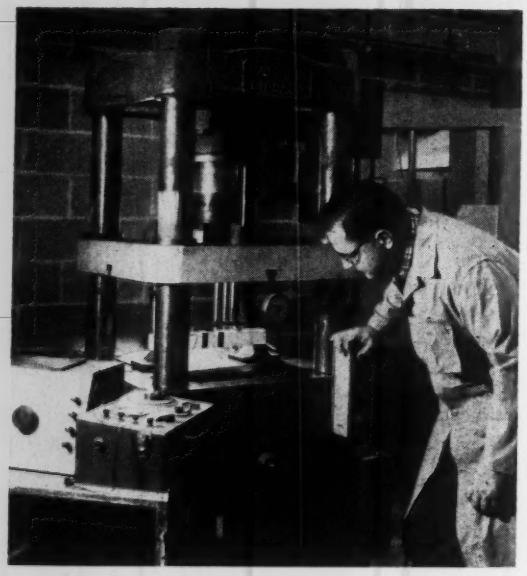
Although packing can be selected to withstand high temperatures, the force exerted by the packing on the stem increases with temperature and can become excessive at high temperatures. This change in force is not permissible in the operation of a reciprocating control-valve stem. A finned cooling section (Fig. 4-18) should be used when the flowing fluid is hot enough to affect the packing. Most specifications call for radiation cooling if the flowing fluid is above 450° F.

Difficulty in operation occurs at low temperatures. For this service, an extension neck between the body and actuator usually is effective.

Radiation from a black surface combined with the low thermal conductivity of stainless steel have been used in the design of a thermal isolating bonnet (Fig. 4-19). A temperature gradient has been obtained to allow the line fluid to be 470° F above the temperature limit of the packing. Condensation of steam (or condensible vapor) retained in an inner stainless-steel tube contributes an additional barrier against conduction of heat to the packing.



George L. Pigman, supervisor of ARF's Fluid Mechanics Section (right), checks weight of fuel in drum during a flowmeter study for the Air Force. Fred W. Rohr, assistant research engineer, measures time of fuel flow during the evaluation.



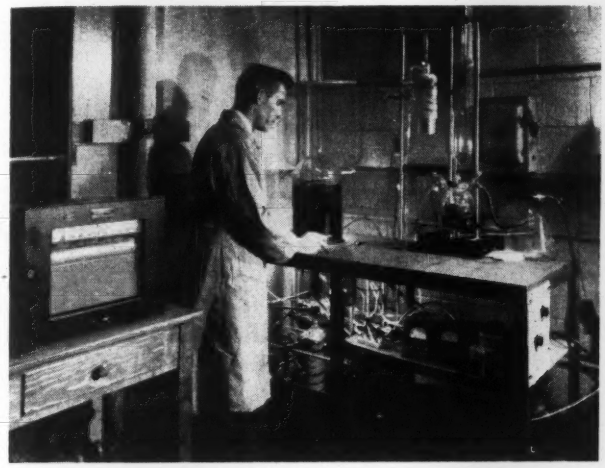
Research ⇄

ARMOUR Research Foundation of the Illinois Institute of Technology is a typical nonprofit research facility serving industry and government, here and abroad (as are Battelle, Mellon Institute, Midwest Research, Stanford Research, etc.). On page 675 you previously met Ed Roberts, head of the Instrumentation Section

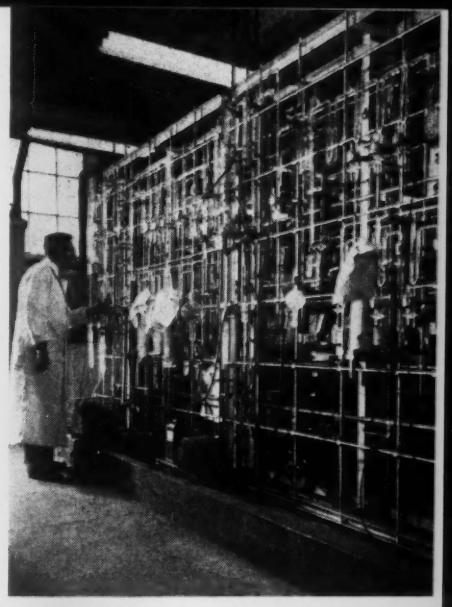
Structural engineer Seymour A. Bortz investigates the flexural strength of a concrete specimen by means of strain gages. Bortz was one of the principal researchers in the Foundation's structural clay products project.

Operating an "IBM 650" high-speed digital computer is Harold H. Kantner (left), specialist in automatic control systems and supervisor of mathematical services. Assistant Electrical Engineer Richard B. Wise is entering information into the computer.

Measuring elastic modulus of a titanium specimen at high temperatures are Raymond Hansen, technician, and Dr. William Rostoker, supervisor of physical metallurgy research. Rostoker has worked chiefly with titanium and vanadium alloys, structure of alloy phases, solidification of metals, and magnetic properties of metals.



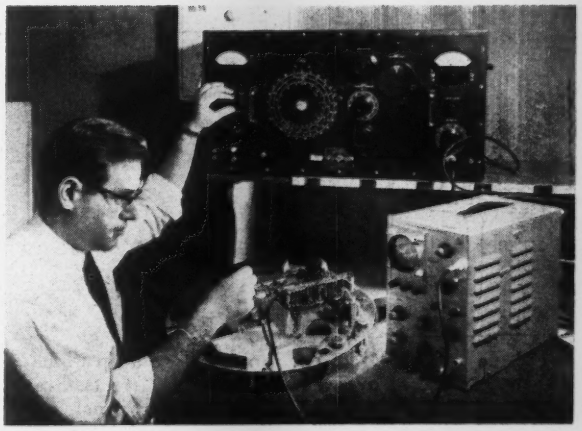
← Dr. Callaway Brown, senior chemist, evaporates semiconducting films used as infrared detectors. Dr. Brown is recognized for his work in surface and crystal chemistry, luminescent materials, high vacuum practice, and air pollution.



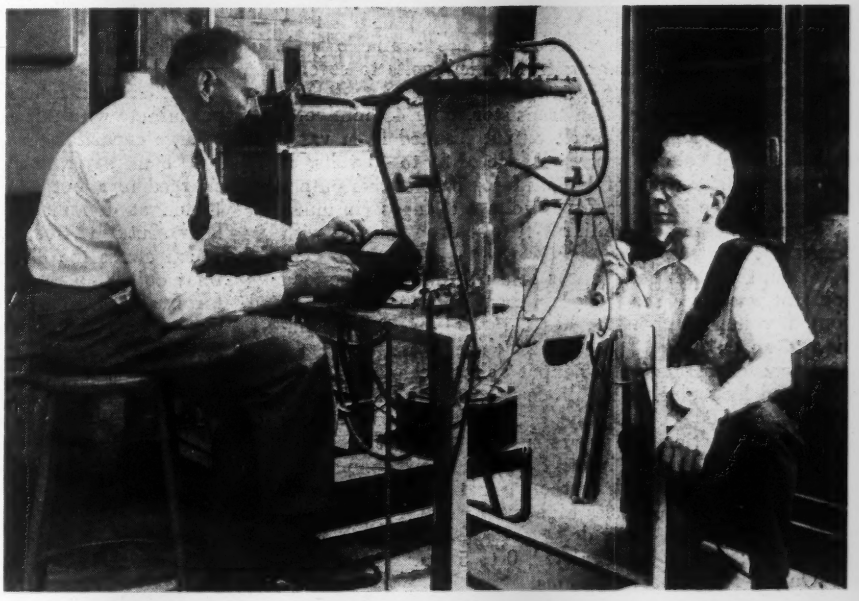
The high-vacuum rack in ARF's Chemistry and Chemical Engineering Research Department is operated by Edward A. Hedman, research chemist.

Instrumentation

of the Electrical Engineering Research Department of ARF. These illustrations are typical of the 500 annual research projects of ARF, which total more than $10 million annually. More than 50 of these projects are ARF-sponsored internal projects, half of which are undertaken as a public service to add to basic scientific knowledge.



Stanley I. Cohn, supervisor of communications and radio frequency applications at ARF, evaluates portion of a transmitter for a specialized radar apparatus.



Preparing to measure the physical properties of ceramic materials under high temperatures and controlled atmospheric conditions are H. Zane Scofield, supervisor of ceramic technology (left) and Samuel W. Bradstreet, supervisor of inorganic technology. Scofield is an authority on applications of ceramic materials in rockets, missiles, high-temperature devices, and nuclear reactors. Bradstreet, co-developer of the "Solution Ceramics" and "Flame Ceramics" processes, has made many discoveries—from a new method for hot-tinning dairy equipment to an electroplating anode.

ELECTRONIC

MILTON H. ARONSON
Instruments & Automation

and

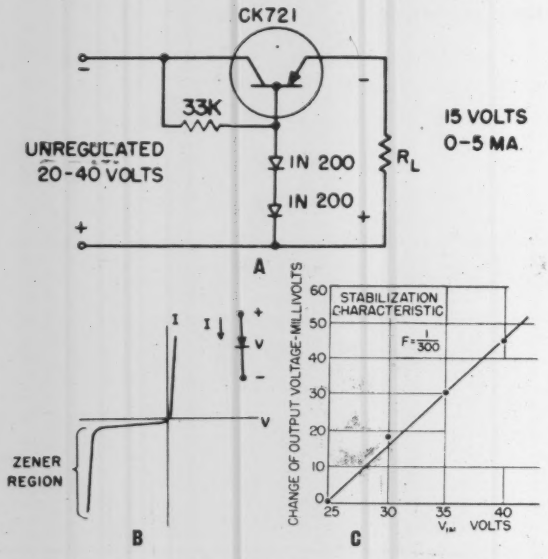
CHARLES F. KEZER
Key Electric Corp.

TRANSISTOR VOLTAGE REGULATOR HAS STABILIZATION FACTOR OF 1/300.

The high voltage-gain and low emitter-resistance exhibited by the junction transistor make possible a voltage regulator circuit with performance superior in some respects to what can be obtained with a single-vacuum-tube regulator. The circuit shown uses a CK721 junction transistor as the voltage regulator, and the Zener breakdown region of junction diodes as the voltage reference.

The voltage-current characteristic of a silicon junction diode has a region where the voltage across the diode is constant for a fairly large change in current (see Fig. B). This "Zener" breakdown region is used as the voltage reference in this voltage regulator.

Two silicon junction diodes (Type 1N200) are used as a voltage reference (Fig. A). Operated in this "Zener" breakdown region (with reverse current greater than



0.125 ma), these diodes develop a voltage drop which is relatively constant over a wide range of currents. Breakdown voltage of the 1N200 diode is approximately 7.5 volts, providing a reference voltage of about 15 volts for the series-connected pair. A desirable feature of this type of voltage reference is that diodes are available with breakdown voltages ranging from a few volts to several hundred volts.

Using a CK721 junction transistor, only 45 millivolts change in the normal 15-volt output resulted from varying the input voltage over the range of 25 to 40 volts, at constant load current of 1 ma. Major part of this output voltage change is due to Zener voltage changes (in much the same way as the familiar V-R tube drop changes with current).

When the input voltage was held constant and the load current was increased from less than 1 ma to 4.7 ma, the output voltage dropped by less than 100 mv, corresponding to an output resistance of 22 ohms.

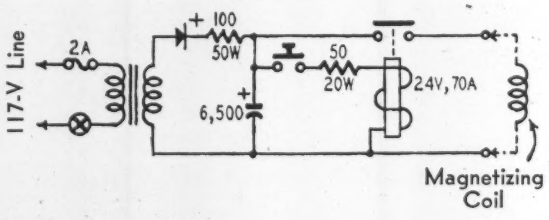
Improved regulation for input voltage changes can be obtained by replacing the diode reference with a battery reference (and deleting the 33,000-ohm resistor). Use of silicon junction transistors such as type TI901 would make possible higher current output than comparable germanium types, and at the same time would permit operation to temperatures higher than 100°C.

Input: —25 to —40 v dc.
Output: —15 v dc regulated, 0 to 5 ma.
Output Resistance: 22 ohms.

Stabilization factor: 1/300 (rate of change of output voltage with respect to input voltage, at constant load current).

Source: R. H. Spencer and T. S. Gray, Massachusetts Institute of Technology; also Transactions Paper 56-41, AIEE.

INEXPENSIVE MAGNETIZER



Permanent magnets can be charged at the rate of four per minute with this simple magnetizer, which discharges a large capacitor through the magnetizing coil.

A bank of electrolytic capacitors totalling 6500 uf is charged to about 125 volts through a selenium rectifier (rated at 400 ma). A pushbutton switch operates the heavy-duty (24-volt 70-ampere) motor-starting relay which closes the circuit to the magnetizing coil. As the relay coil is operated from the voltage across the capacitor bank, the relay opens before the capacitor is fully discharged; as the current is low at this time, relay contacts need not interrupt heavy currents. Input transformer is a 1:1 isolation transformer.

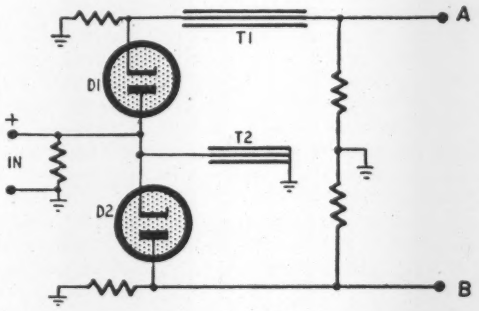
Magnetizing coil should have 150 to 200 turns, be no larger than needed to accommodate the parts to be magnetized, and have a d-c resistance of 0.3 to 1.0 ohm. Peak current of about 150 amps has a duration of 2 milliseconds. In some cases, best results are obtained by slowly withdrawing the object from the coil, as the final pulsation may leave it only slightly magnetized.

Source: *Radio-Electronics*, Dec., 1953; also *National Bureau of Standards Technical News Bulletin*.

CIRCUITRY

The circuit is the heart of all electronics. Here are 4 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

BALANCED PULSE CIRCUIT PROVIDES PUSH-PULL OUTPUT



This circuit converts a single-ended (unbalanced) pulse to balanced (or push-pull) output. Circuit shown works on positive pulse inputs only, although operation from negative pulses is readily accomplished.

T1 and T2 are delay lines. A positive pulse at the input travels through diode D1 and through T1 to the output, appearing at A. It also passes through T2 to the shorted termination where it is reflected as a negative pulse back to the input. This negative reflected pulse passes through D2 (D1 is cutoff) and appears at output B. Delay line T1 has twice the delay of T2; thus the positive pulse at A appears simultaneously with the negative pulse at B, and a balanced output is obtained.

Circuit resistances are chosen to terminate the delay lines properly to avoid unwanted reflections and to obtain the same attenuation for both pulse outputs.

Length of T2 must be such that the input pulse is ended before the reflected pulse arrives back at the input, and the repetition rate of the input pulses must be such that the reflected pulse is ended before the next input pulse arrives.

Source: U.S. Patent No. 2,665,413, Abraham Hyman, New York, NY; also *Radio-Electronics*, June, 1954.

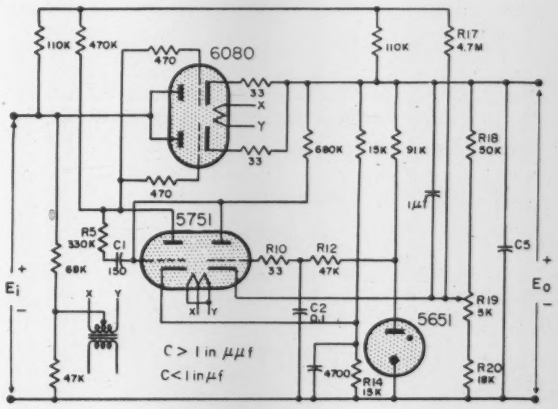
300-v REGULATOR HAS 1% REGULATION

This circuit, when used with a regular power source, provides plus or minus 300 v at 200 ma (2 sections of the 6080 in parallel) with 1% regulation. It is NBS-BuAer Preferred Circuit PC3A.

Circuit is a conventional series-regulator-tube circuit. The 6080 (6AS7 equivalent) is chosen for its low plate resistance and high heater-to-cathode voltage rating. The 33-ohm cathode resistors equalize the currents in the triode sections; the 470-ohm grid resistors suppress parasitic oscillations.

The network R12-C2 attenuates transient noise spikes characteristic of glow discharge tubes; R10 suppresses parasitic oscillation.

The 5751 (12AX7 equivalent) is a 2-stage d-c-coupled amplifier that controls the series resistance of the 6080.



Its loop gain is more than 1000. The plate supply for the output section is taken from a voltage divider across the series tube in order to decrease the required plate swing. This is done as a compromise between (1) the high input voltage and (2) the steady output voltage. If the 5751 were fed from the input supply alone, an excessive plate swing would be required because as input increases, the output plate of the 5751 must swing negative to compensate. Hence using the input alone for the plate supply would require twice as much compensating swing.

Feedback network R5-C1 reduces the high-frequency output impedance.

Output capacitor C5 should be 4 or 8 uf.

Resistor R17 decreases the output resistance and increases the stabilization by feeding a portion of the input voltage change to the cathode of the 5751.

The divider R18-R19-R20 across the output determines the amount of signal fed to the input stage of the 5751, and hence circuit is very sensitive to this divider ratio. Divider should use resistors whose wattage ratings are conservative and in the same ratio as the power dissipation in order to keep the ratio reasonably constant with temperature change.

Input: 350 v minimum.

Output: 300 v.

Maximum load current: 125 ma per triode section of 6080 when one 6080 is used; 100 ma per section when 2 or more are used in parallel.

Regulation: 1%.

Output Impedance: Less than 1 ohm at all frequencies up to 100 kc.

Source NavAer 16-1-519, *Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment*, National Bureau of Standards, Washington, D.C.

Linear-Feed-Rate Indicator uses Magnetic Drum

J. F. DUNDOVIC
The Maico Company

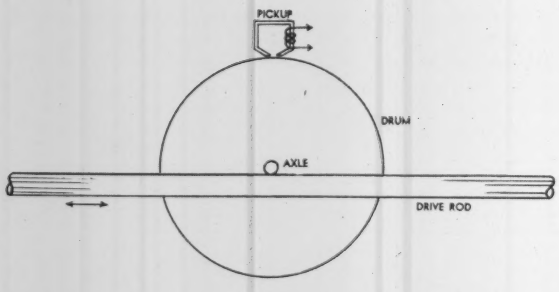


Fig. 1. Linear feed rate of drive rod is converted into an a-c signal by magnetic track placed on drum.

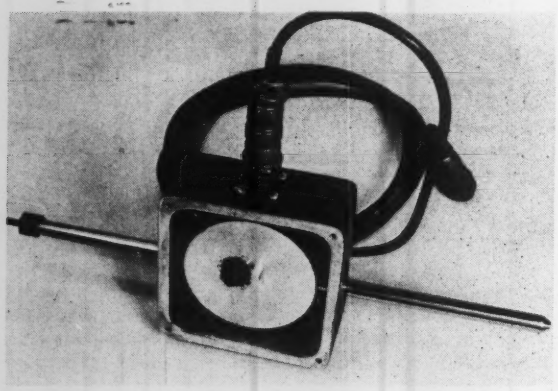


Fig. 2. Pickup head can be seen in upper-left corner of the pickup unit.

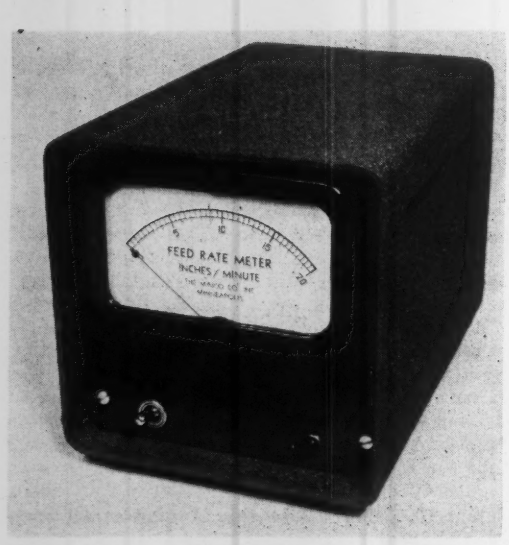


Fig. 3. Indicator is essentially a frequency indicator with scale graduated in feed rate units, such as inches per minute.

IN the machine-tool industry there is a trend toward use of hydraulically powered feeds for lathes, milling machines and other types of equipment; smooth and continuously variable control plus the absence of gearing are reasons for using this type of drive system. However, temperature changes in the hydraulic oil can alter the viscosity and cause drifting of the feed rate. Also, it is difficult to set up and measure the desired rate of feed and detect changes over a period of time. This has pointed up the need for a simple indicating device which can be placed on hydraulic machines for the purpose of giving continuous readings of linear travel rates.

A tachometer generator connected to the lead screw or pinion will measure feed rate satisfactorily for machines using motor-driven feeds. With hydraulic drives, however, it is necessary to convert the linear motion to rotary movement in order to develop a usable electrical signal proportional to the rate of travel. The problem is not a simple one, as some reflections on the use of racks and gears will show.

Fundamentally, the ideal feed-rate meter should be capable of measuring and indicating speeds from a minimum of 0.25 inch per minute to as high as 150 inches per minute. The pickup unit should be able to accommodate any total travel required by the machine. It should be compact, rugged, reliable, and easily attached to existing machines of all types. Excessive accelerations and traverse speeds must not cause damage to the pickup or meter. And, of course, it should not be so expensive as to limit its use.

In order to meet these requirements, a feed-rate meter using a novel technique was developed. The pickup unit (Fig. 1) is the heart of the device. An aluminum drum is mounted on a small steel shaft which is friction-driven by a steel rod connected to the carriage of the machine. The surface of the drum is coated with magnetic oxide and has recorded on it an a-c magnetic track. Spaced closely to the track is a magnetic pickup head which develops a signal frequency directly proportional to the speed of drum rotation, and independent of direction.

The speed of the drum surface past the pickup head is equal to the carriage speed times the ratio of the diameter of the drum to that of the axle. The multiplication of speed aids in reading slow feeds because a higher frequency signal is generated and the voltage output of the head increases with frequency.

Fig. 2 shows the pickup unit with the cover plate removed to show the interior of the case. In the upper left corner of the compartment is the pickup head. The

3-inch drum is mounted on a 3/16-inch hardened steel axle which rests on the drive rod. The drum axle rides on ball bearings and is spring-loaded against the drive rod with a force of about one pound. As the actual contact area is small, the pressure is great enough to break through any oil film which exists. Slippage occurs only momentarily during sudden speed changes, a protective feature.

The indicator unit is shown in Fig. 3. It is essentially a frequency meter with a linear scale calibrated in inches per minute. The circuit is self-limiting so that rapid traversing can not injure the indicator movement. The readings are unaffected by signal amplitude and power line fluctuations. However, like all such instruments, the calibration can eventually shift due to aging of the tubes. The operator can quickly check the calibration by pressing a button on the rear panel. This applies to the input a reference frequency of 120 cycles per second derived from the power line. By turning an adjustment knob until the meter reads exactly on the calibration check mark, he can make certain that the instrument is accurate.

The scale shown is 0-20 inches per minute. Other scales can be substituted provided a simple change is made in the meter circuit to allow for the different frequency range from the pickup unit. No change is required in the pickup itself. Sample scales are 0-5, 0-50, and 0-100 inches per minute.

Although the feed rate meter was developed primarily for use with machine tools, applications will be found wherever linear-motion rate measurement is desired.

The author wishes to acknowledge the contributions of John W. Hogan, inventor of the feed-rate-meter pickup.

Large-Screen Scope Reduces Testing Time by 90%

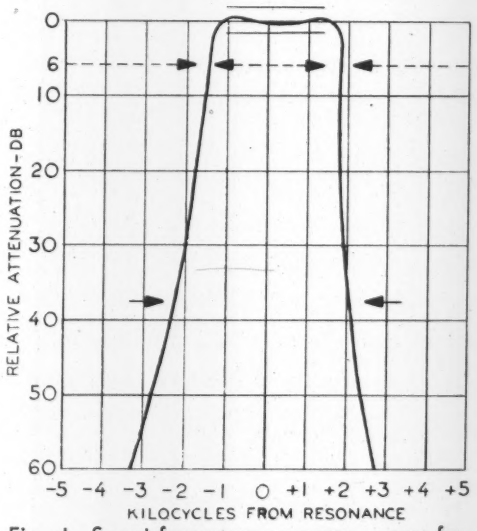


Fig. 1. Swept-frequency response curve for a typical filter.

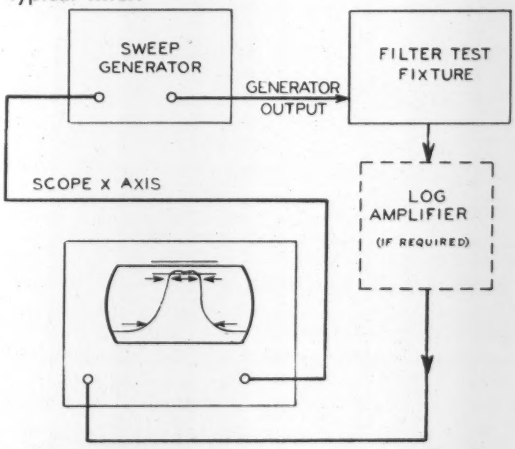


Fig. 2. Block diagram of equipment in Fig. 3.

USE of a large-screen oscilloscope has reduced the time required to test the Collins Radio mechanical filters from more than ten minutes per filter to less than one minute.

The filters are produced at a rate of more than 300 per day. The problem was to test the performance of the filters to precise tolerances accurately and at a rate which would eliminate a production bottleneck.

A large-screen 17″ oscilloscope provided the answer. The tolerances were marked on the graticule of the scope as indicated. When it is realized that the distance between the opposing arrows on the screen is 0.3″, the necessity for a large-screen scope becomes obvious.

The response curve is produced by a swept-frequency method. Figs. 2 and 3 show the equipment and set-up necessary to produce this display. It is applicable not only to the test of mechanical filters but also to any frequency-sensitive device.

The equipment shown in Fig. 3 includes an Electromec 17″ oscilloscope and a Berkeley EPUT meter.

Availability of such 17″ and 21″ scopes permits tolerances or values of low order to be used as standards.

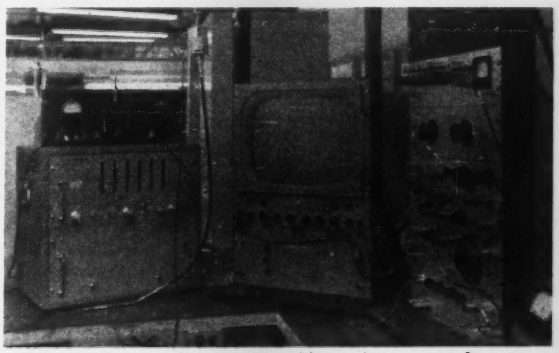


Fig. 3. Set-up for testing filters by swept-frequency method.

Estimating Electronic Equipment

Cost estimates for control equipment need not be highly accurate, but should include all cost factors, including depreciation, amortization, tax structure, investment charge, maintenance costs, property taxes, insurance, record keeping, power costs, and storage costs. Here is an analysis of all these factors, leading to a comprehensive picture of the true orders of magnitude of factors often overlooked.

KENDALL D. MOLL
Stanford Research Institute

NEARLY all engineers must occasionally make decisions regarding equipment policy; equipment costs become a key factor. However, the usual technical approach to these questions does not consider all of the financial and indirect factors involved.

In typical research and industrial organizations the usual factors to be included are depreciation, investment charges, maintenance, and incidental costs, all of which can be estimated on a standardized basis. Intangible factors such as losses due to equipment inaccuracies or breakdowns, worth to an organization of a particular equipment item, and financial considerations of a particular concern must, of necessity, be considered in the individual case.

In order to arrive at an over-all cost estimate, the various factors must be considered in equivalent units. The most logical basis for this is in terms of yearly costs. Yearly costs for such factors as maintenance and incidental costs may be estimated directly. To convert purchase price to yearly costs, a depreciation rate which "writes off" the original investment must be used. A yearly interest charge for the remaining investment then can be computed from the undepreciated balance.

Depreciation

Depreciation is usually the most important of electronic equipment costs. It is similar to rental in that it is a cost for use of equipment during a given period. The cost does not necessarily correspond to the amount of service during the period. It is more accurately defined as a decline in resale value—that is, what we pay for equipment less what we can sell it for.

Obsolescence, or inferiority relative to newer products, causes more of the depreciation decline in electronic equipment value than does deterioration, or physical aging and wear. As obsolescence depends on the availability of better replacements, it is also a highly variable quantity which cannot easily be predicted on the basis of previous experience.

A cursory examination of second-hand values (resale price less 20% for disposition costs) is plotted in Fig. 1. Some old items, such as DuMont 208B oscilloscopes, continue to sell for close to their original price. On the other hand, some relatively new but obsolescent items suffer high depreciation.

For any particular equipment, a direct appraisal of the resale value would be superior to an arbitrary assumption. But second-hand market value is usually inconvenient to estimate, especially for future values. Although the range of possible depreciation rates is great, we may in general assume an average value when specific information is lacking.

The average resale value is seen from Fig. 1 to decline at about 20% of the remaining balance each year. The method of computing this depreciation curve is known as the *declining balance method*. It is characteristic of the depreciation behavior of many manufactured products and provides a consistently diminishing charge which parallels diminishing use of aging equipment. The declining balance method is also easier to calculate than other nonlinear depreciation methods.

However, to define depreciation as a decline in second-hand value is not quite correct, since some aspects are not adequately reflected in the resale price. Allowances should also be made for income tax policy, concealed obsolescence, and attrition.

The depreciation schedule established for income-tax purposes is important because effective depreciation costs tend to follow this schedule, even though the actual record of a particular item may be quite different. For example, suppose an item is disposed of for $100 more than its depreciated value. The $100 is ordinarily treated as capital gains, so only $75 will remain after taxes.

Costs

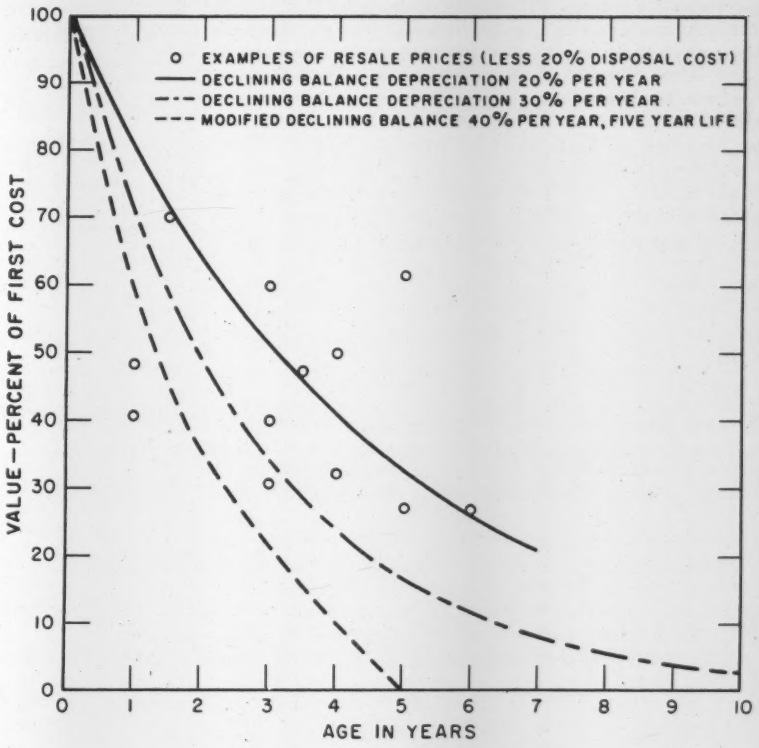


Fig. 1. Dots show resale value for different instruments over a 6-year period. Although depreciation of some is more than 40% per year, and others less than 20%, the average is about 20% of the remaining balance per year. The 30% per year declining balance is suggested as a compromise rate after consideration of the tax situation.

Amortization and Taxes

Some adjustment of the 20% per year declining-resale balance curve should be made to allow for the effect of the tax schedule. Inquiries among the accounting departments of nine electronics organizations disclosed that the majority amortize their equipment over a five-year period. Some companies use considerably shorter lives. For tax purposes, the most preferable write-off for a five-year life is a 40% declining balance curve, modified to provide a zero balance at the end of five years. This is the dash curve in Fig. 1. Where capital gains tax is 25%, the appropriate correction factor would be one-quarter of the difference between the resale and the tax schedule values, corresponding approximately to a 25% per year declining balance curve.

A company may occasionally be permitted to accelerate its depreciation on electronic equipment purchased for use on military contracts ("Certificate of Necessity"). In this case, the accelerated schedule should be used as the effective depreciation rate, because any income from resale greater than the amortized value would merely be deducted from the profit on the contract.

One aspect of the effect of taxes on depreciation might warrant further reflection. The assumption is commonly made that because profits are taxed at 52%, purchases actually cost only 48 cents on the dollar. This is true only under one condition: that the purchase results in a total loss. Otherwise, a reduction of 48 cents in present after-taxes profit will require an extra dollar of future gross profit in order to recover the loss. If the purchase is expected to result in more profits, as even long-range research is expected to do, then it will have to recover all that it cost.

Concealed Obsolescence

Losses due to concealed obsolescence and attrition will cause a second increase in the 20% per year resale depreciation curve.

Obsolescence is sometimes concealed because established buying habits hold resale values above the true relative worth. Old equipment frequently sells for more than new equipment of comparable performance simply because it is known and accepted.

Attrition of older equipment also tends to elevate the price of surviving items by reducing the available supply. In addition, the non-surviving items are lost without any resale value. Both attrition effects act to reduce the average depreciated value below what resale prices would indicate.

We can assume the increase in depreciation due to concealed obsolescence to be 5% per year, so that the over-all depreciation would be 30% per year.

Thus, the 30% per year declining balance method is suggested for use as an average depreciation rate. But it should be emphasized that this rate does not account for the possibility of abnormal obsolescence or deterioration, or for tax treatment different from the method set forth. Where these factors may be relevant, the depreciation rate should be shaded accordingly. The suggested method also assumes that resale value is to be considered when disposing of equipment. Where this is not true, the depreciation rate may be based on the tax write-off or some other criterion.

Investment Charges

"Investment charge" or "rate of return" is taken to be the amount of return expected for investments. In

Government agencies, this would usually be the cost of borrowed money. For private business this charge must also reflect the risk involved as well as the amount of return to be expected from competing uses of the funds.

Where applicable, the expected gross return is considered to include both net return and income tax. If the tax rate is 52% and the expected net return is 10%, then the gross return is 10% divided by 48%, or about 21%. The method assumes that the ratio of operating costs to investment will remain constant, but this approximation is probably adequate for our analysis.

Investment charges in Government agencies are of the order of 3%. Non-profit organizations might require from 5% to 15%. Organizations in philanthropic or basic research might tend toward the low side of the range; applied research foundations serving industry would be somewhat higher. Private companies subject to income tax would require a gross rate of perhaps 10% to 30%. Variation within this range would depend on the stability of the company, prevalence of opportunities for investments, and availability of capital.

The same criterion should be used for research and development investments as for other investments which contribute to the needs of the business. Research, production, and working capital are distinguished by the nature of their services, but the money required all appears on the same profit-and-loss sheet.

Maintenance

It has been found that first cost, in general, is a better measure of electronic maintenance cost than other commonly used standards, such as tube population. This is probably due to the close relationship between first cost, complexity of construction, and the amount and difficulty of maintenance. The chief problem of estimating maintenance cost by tube population is the variability of both tube performance margins and associated circuit complexities.

Accurate maintenance cost figures are generally available only for programs of regular preventive maintenance. Perhaps this is because the organization required to establish preventive maintenance is also necessary to obtain accurate cost figures. At any rate, the direct costs for a minimum preventive program are probably not significantly higher than for a breakdown repair program. The increasing prevalence of preventive maintenance programs indicates that the over-all cost under this system, considering increased efficiencies in equipment use, are actually lower.

Typical Maintenance Costs

Available data indicate a wide range in maintenance costs for different equipments and environmental conditions. Some typical examples are given in Table 1.

However, for quality laboratory test equipment the maintenance costs are much lower. A commercial maintenance service organization provides a complete preventive maintenance program, including emergency servicing, to electronic concerns for approximately the percentages of original cost shown in Table 2.

The rates shown include all labor, overhead of slightly more than 100% on the labor, and materials at 35-40% of labor. Twice yearly servicing is provided with emergency repair of breakdowns. About 7% of the instruments fail between servicing.

Table 1.—Typical Maintenance Costs

	Percent per year
Military equipment	100—1000
Police and fire equipment	15—25
Low priced electronic test and servicing equipment	15—25
Household TV sets	15—20

Table 2.—Maintenance Costs for Electronic Equipment

7½% per year:	Complex oscilloscopes
	AC vacuum-tube voltmeters
	Audio oscillators
6% per year:	Multivibrator circuitry (Counters, pulse and sweep generators)
	Audio amplifiers, pre-amplifiers
	Simpler oscilloscopes
	Frequency meters
	Q meters
	Impedance bridges
	Variable filters
4½% per year:	Power supplies
	Oscillators
	Distortion analyzers
	Harmonic wave analyzers
	High frequency amplifiers
3% per year:	Step and variable attenuators
	High quality DC vacuum-tube voltmeters

Preventive Maintenance Program

Service of equipment every six months seems to be the most common schedule of preventive maintenance programs. With less frequent scheduling the necessity for emergency repairs increases, performance deteriorates, and calibration inaccuracies become more likely, so that the advantages of preventive maintenance tend to be lost. However, infrequent scheduling is cheaper, especially for items requiring less maintenance. Direct costs for preventive maintenance once a year might be 20-30% less than for a six-month schedule.

Some consideration must, of course, be given to the usage in estimating maintenance costs. The rates quoted above assume an average of four to eight hours running time per day. Two-shift continuous operation requires a 66% increase in tube replacements, or approximately 25% increase in maintenance cost. Operation much less than four hours per day will decrease costs in a similar ratio.

Costs are not directly proportional to use because a regularly scheduled preventive program is largely a fixed cost. Heavy use of equipment will sacrifice some reliability in exchange for a saving in direct maintenance cost per equipment-hour. The optimum balance between maintenance cost and equipment reliability can only be realized through experience in adjusting the maintenance program to the duty of the equipment and the needs of the user.

Table 3.—Cost for Storage of $4000 Equipment in 2' x 3' x 5' Cabinet

Cabinet and Shelving	$15.00
Building and Maintenance	10.00
Janitorial service	2.50
Light and Heat	1.50
	$29.00

Table 4.—Cost of Incidental Factors

Taxes	2 %
Insurance	0.7%
Record Keeping	1 %
Power	0.5%
Storage	0.7%
Adding up to a total of:	4.9%, or about 5% per year.

Table 5.—Over-all Costs for Equipment

	1st Yr.	4th Yr.	7th Yr.
a. Depreciation (30% per year declining bal. method)	30%	10.3%	3.6%
b. Investment charges (20% of bal. of beginning of yr.)	20%	6.9%	2.4%
c. Maintenance (6%)	6%	6 %	6 %
d. Minor Costs (5%)	5%	5 %	5 %
TOTAL	61%	28 %	17 %
Total yearly cost for $1000 Equipment	$610	$280	$170

Incidental Costs

Equipment ownership also entails charges for services and facilities such as property taxes, insurance, record keeping, power and storage.

Property Taxes

Typical property taxes are of the order of 3 to 7% of assessed valuation. The assessment base, again, is highly variable; usually it amounts to from ¼ to ½ of the apparent value. Although the assessment theoretically should reflect actual (depreciated) values, in practice the assessment, once assigned, tends to stick to that value. Considering all of the above factors, we can assume an average tax rate to be about 2% of the original price per year.

Insurance

Within wide limits primarily determined by the building, surrounding environment, municipality, and detailed provisions of the policy, an "inland marine" insurance policy affording protection against fire and theft and extended coverage will usually run from 1 to 1½% of the insured value per year. In terms of original cost, the average insurance will be of the order of 0.7% per year.

Where property taxes are high, municipal services are usually good and insurance rates tend to be low. Variations in these two costs will be self-canceling to some degree.

Record Keeping

Record keeping serves one purpose for operational control and another for accounting and legal needs. The records required for maintenance and operation are included in this paper under the maintenance costs.

Formal property records do not directly serve the operating people, and the clerical work involved is usually a staff function. This work entails a considerable overhead cost which runs, for one company at least, in the order of 1% per year.

Power Costs

Costs of power will depend directly on the power consumption, frequency of use, and kilowatt-hour rate. Power consumption per dollar of purchase price for most test equipment will vary over a 3:1 range, but the average is about 0.3 watt per dollar. Power at line voltages will cost about 1½¢ per kilowatt-hour. Assuming an average of five hours use per working day, the cost of power works out to about 0.5% of the original cost per year. This amounts to 0.1% for each hour of use per day.

If an estimate for a specific item were desired, the following more detailed formula might be used:

0.4 x watts consumption x average hours use per day = yearly cost for power.

Storage

Although storage is not a commodity that is purchased along with the equipment, storage cost should in the long run be charged against the equipment. Usually space is available for another item, but there always comes a point when "something has to go" or when more space becomes necessary. Consider a 2′ x 3′ x 5′ cabinet containing an average assortment of test equipment totalling perhaps $4,000 in original value.

The yearly cost for this cabinet and the associated space might be as shown in Table 3.

This figure is equivalent to about 0.7% per year of the original price and will remain constant over the life of the equipment.

Summary of Incidental Costs

Recapping these minor costs in terms of the original price, we find the typical rates shown in Table 4.

Use of Total-Cost Estimates

Having examined the costs to be expected from equipment ownership, let us relate them to a hypothetical example.

Assume that a function generator costing $1,000 is desired for immediate use. We would like to estimate the cost for the immediate use and for future possible needs. This is done in Table 5.

Thus, for this case we see that use of the equipment will cost over half the purchase price for the first year.

This example illustrates one possible use for equipment cost estimation. Other applications might be to compare costs of alternative testing methods, to review costs of retaining marginal older equipment, and to assist in evaluation of costs for research organizations.

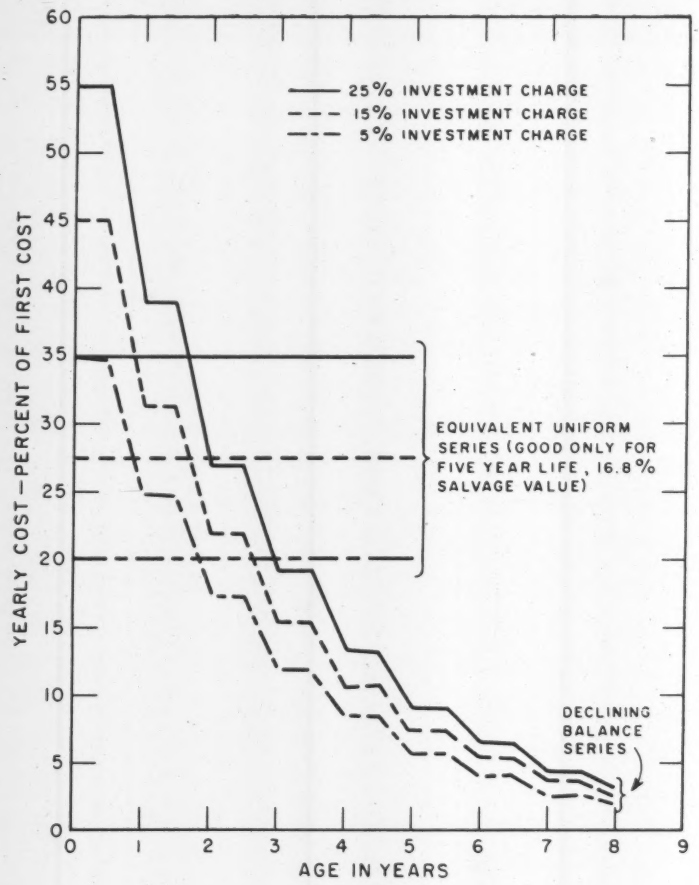


Fig. 2. Estimating average yearly costs on the basis of 5-year life and 16.8% salvage value. Average of the declining balance series over the 5-year period at 25% investment charge is seen to be about 35%.

Average Yearly Costs

We may at times wish to estimate average yearly costs over the life of equipment. To obtain a uniform annual series of charges equivalent to declining balance depreciation and investment costs, a particular life (and salvage value) must be assumed. A different assumption will give a different uniform annual series. Calculation of the exact amount is rather involved, but in general a short life will yield higher equivalent annual charges than a long life. Three uniform annual series (at three rates of interest) for one set of conditions (5-year life and 16.8% salvage value) are given in Fig. 2.

When equipment is purchased from a capital budget, decisions usually hinge on the amount of money available in the arbitrary budget instead of on the actual worth of the investment. Although budgets are a necessary management convenience, justification for purchase should, in the final analysis, be based on overall costs vs. benefits. The prospective purchase may be harder to justify on this basis than by a casual glance at the capital budget.

Cost estimates need not be highly accurate in order to be of service. Exact data for all the subsidiary factors are not needed to obtain a reasonable estimate of total equipment costs. Similarly, exact total cost is not necessary for an estimate that will be of value in planning and decision making.

Intangible factors—worth of the equipment to the organization, convenience and reliability of operation, and general financial considerations—are the real uncertainties of equipment policy. If we understand the general magnitude and behavior of the costs, we have a useful scale against which to judge the intangibles.

Acknowledgements

Data on maintenance costs were contributed by Mr. Jay Dobrin from original records maintained by the Western Scientific Instrument Co., San Carlos, Calif. Acknowledgements are also due to Prof. E. L. Grant of Stanford University, and Messrs. C. L. Alcorn, S. W. Lundberg, and N. R. Maines of Stanford Research Institute for their advice in the preparation of this paper.

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Principles and Practice of ORIFICE METERING

Practical considerations in achieving high-accuracy flowmetering include (1) effect of liquid over mercury, (2) gas density effect, (3) flow vs standard volume-units, (4) viscosity effects, (5) meter run, (6) meter location, (7) impulse lines, (8) pressure taps, (9) vapor binding and (10) moisture and hydrate formation. Accuracy is shown to be between 1.5 and 3% for average industrial conditions.

CLAUDE B. NOLTE
The Barton Instrument Corp.

History

ALTHOUGH concepts of flow measurement extend back to early Egyptian days when the priests used graduated holes placed in the Nile river to gain some idea of the volume of water flowing in the river bed, commercially practical measurement of the rate of flow of fluids through pipelines had its beginning in the work of an American engineer by the name of Herschel, who first produced the device that we know as a Venturi tube. His work was conducted in the latter part of the 19th century, principally in the field of water works.

Use of the orifice meter was given its first real impetus about 1915, when the government sought a practical field instrument suitable for measuring gas produced along with oil from certain Indian territories in Oklahoma. Two men whose names are associated with instruments and flow measurement, Westcott and Weymouth, conducted experiments which demonstrated the practicality of the use of an orifice plate and a differential-pressure-measuring device (a mercury manometer) for determining gas flow. To their early work has been added a monumental amount of investigation, with the result that accuracy of flow determination has kept pace with industrial and utility demands for enhanced accuracy.

Many handbooks now are available which give the mathematical basis for flow measurement theory, and which also present the enormous amount of empirical data necessary to make the theoretical concept practical. Although some attempt will be made to summarize this theoretical and empirical information, more emphasis will be placed on the practical aspects of flow measurement which will be of assistance to the engineers and technicians in the field.

May Meeting: *Thursday, the 17th, Rio Hondo Country Club, Downey, California.*

Feature: *Frank E. Reeves, Automatic Switch Co., will present a paper on "Construction and Application of Solenoid Valves."*

Types of Flowmeters

There are several varieties of flow measuring apparatus. As this discussion is limited to the orifice-meter type, only a brief mention of the other styles will be made. One method of flow measurement establishes the rate of flow by determination of the *velocity of rotation of a propeller* mounted in the flow stream. Another type of flow measuring device, such as the household water and gas meters, *counts specific volumes* as the gas or liquid passes through it. There is also a near cousin to the orifice meter known as the *variable-area meter*, wherein a float bob rises or descends in a conical-shaped tube oriented in a vertical position, with the gas or liquid flowing in at the bottom and out at the top; the rate of flow is interpreted from the position of the float inside the tube.

Orifice Principle

The orifice meter is an interpretive or inferential-type instrument in that it does not measure rate of flow in a direct fashion, but requires that empirical data be available to interpret into flow units the thing that it does measure—namely, difference in pressure across an orifice plate. Essentially, the orifice meter operates on the theory that is defined by Bernoulli's theorem, which

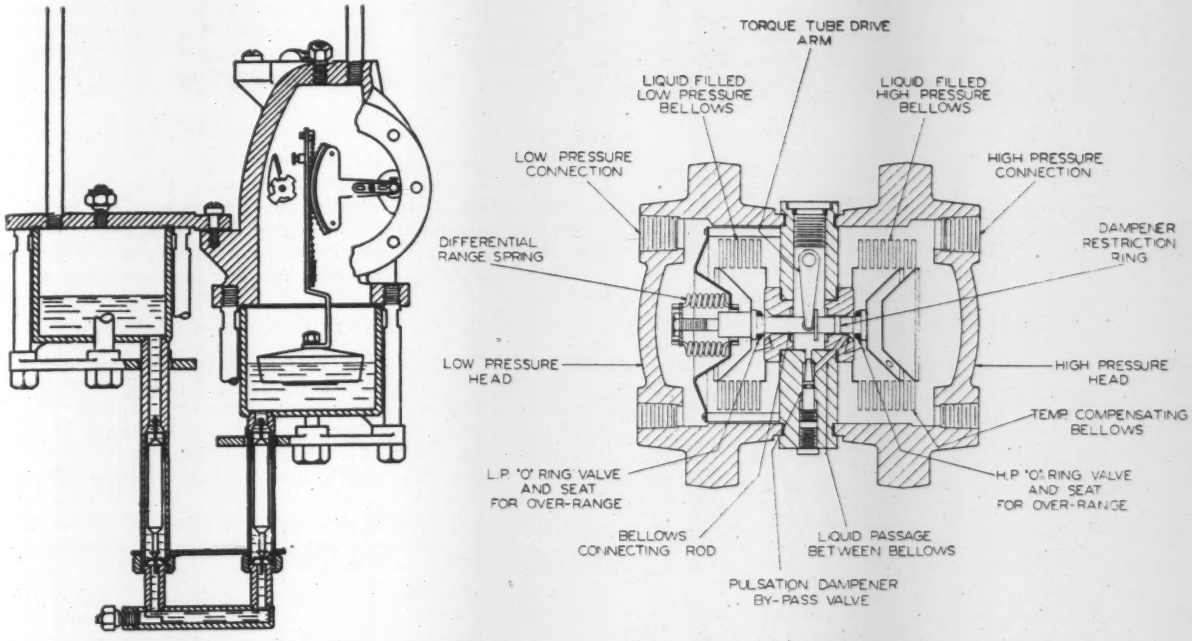

TORQUE TUBE DRIVE ARM
LIQUID FILLED LOW PRESSURE BELLOWS
LIQUID FILLED HIGH PRESSURE BELLOWS
LOW PRESSURE CONNECTION
HIGH PRESSURE CONNECTION
DIFFERENTIAL RANGE SPRING
DAMPENER RESTRICTION RING
LOW PRESSURE HEAD
HIGH PRESSURE HEAD
TEMP COMPENSATING BELLOWS
L.P. "O" RING VALVE AND SEAT FOR OVER-RANGE
H.P. "O" RING VALVE AND SEAT FOR OVER-RANGE
BELLOWS CONNECTING ROD
LIQUID PASSAGE BETWEEN BELLOWS
PULSATION DAMPENER BY-PASS VALVE

Fig. 1. Basic flowmeter types include the mercury-manometer type (left) and bellows type (right).

is a re-formulation of one of the basis laws of physics—namely, the conservation of energy. Bernoulli's theorem explains that the energy in a flowing fluid is made up of the energy resulting from the pressure of the fluid as well as the energy associated with the velocity of the flow. As the total energy is the sum of these two factors (pressure and velocity) if the velocity of flow in a pipeline increases, the static pressure (the pressure read by a pressure gage attached to the pipe) must decrease. In mathematical terminology this becomes:

$$P_1 + (1/2)CV_1^2 = P_2 + (1/2)CV_2^2$$

P_1 = Pressure upstream of orifice
P_2 = Pressure downstream of orifice
V_1 = Velocity upstream of orifice
V_2 = Velocity downstream of orifice
C = Fluid density

Converted into practical form, this becomes

$$W = (F_C)(0.1)(D_1^2)(\sqrt{G})(\sqrt{h})$$

W = Rate of flow, pounds per hour
D_1 = Pipe inside diameter, inches
G = Density of flowing fluid
h = Differential pressure, inches of water
F_C = Flow coefficient

For flow measurement to be practical, extensive empirical data for F_C are required.

The Orifice

The orifice plate is a thin metal member with a hole in it smaller than the inside diameter of the pipe in which it is inserted. Pressure connections are made in the pipe adjacent to the upstream side and the downstream side of the orifice plate. The difference in pressure at those two spots, resulting from the change in velocity as the liquid or gas passes through the orifice or restriction, is measured by the differential-pressure sensing device, of whatever nature, and its readings interpreted through basis equations into flow measurement.

Such data have been accumulated through the years by research and technical organizations; they are available to engineers and technicians.

Beta

F_C varies both with the diameter of the pipe through which the fluid is flowing and with the ratio of the diameter of the hole in the orifice plate to the inside diameter of the pipe. This ratio of orifice I.D. to pipe I.D. is known as *beta*. Tables and graphs are available which show the relationship between F_C and beta for various pipe sizes.

This relationship is also a function of the location of the pressure connections adjacent to the orifice plate. The connection most commonly used in the United States is the *flange connection*. However, other types are used, and a basis for correlating the various types will be presented.

Flange Connections

Flange connections (Fig. 2) are located arbitrarily 1″ upstream and 1″ downstream from the upstream and downstream faces of the orifice plate. They derive their name from the fact that they are drilled into the flanges installed in the pipeline for the purpose of holding the orifice plate in position. This is the most commonly used connection because of its simplicity. Welded neck flanges are complete and need no additional work done on them; however, in the slip-on flange the pressure hole must be drilled through the pipe after the weld has been made. The same applies to the threaded flange. Reliable flow coefficient data are available for flange connections.

Line Pipe Connections

Line or pipe connections are located 2½ pipe diameters upstream from the orifice plate and 8 pipe diameters

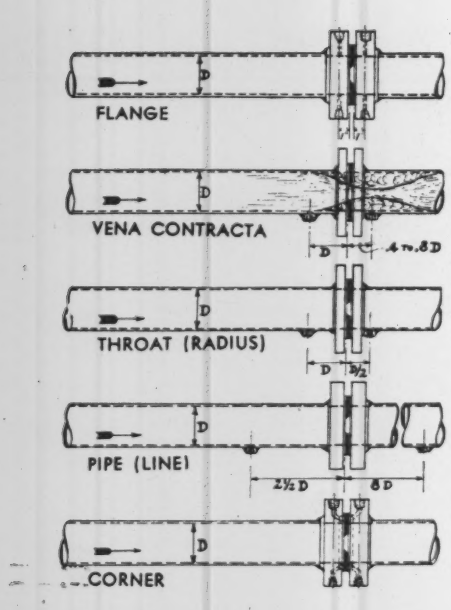


Fig. 2. Pressure connections to line can be of these five basic types—flange, vena-contracta, throat, pipe and corner. Flange connections are most commonly used because of their simplicity; vena-contracta taps give the largest differential signal; line connections give the lowest signal and are used in low-pressure gas measurement; the throat tap is an approximation to the vena contracta; corner connections are particularly useful on small pipelines.

downstream from the orifice plate. Obviously, the pipe connection must be provided on the pipe at the time of installation. This requires a provision for a threaded connection for the attachment of the impulse lines to the pipe as well as perforation of the pipe itself.

Line connections give the lowest differential pressure signal for a given flow rate. Therefore, they are the most practical connections to use in low-pressure gas measurement where minimum pressure drop across the orifice plate is desired. Reliable flow coefficients are available for this style connection also.

Vena-Contracta Connections

This form of connection is used when the maximum differential-pressure signal is desired for any given rate of flow. The upstream connection is located approximately one pipe diameter from the upstream face of the orifice plate; the downstream tap is a distance from the downstream face of the orifice plate that depends on the ratio of pipe diameter to orifice diameter. The smaller the ratio, the closer the tap is located to the plate itself. Roughly, it is one-half pipe diameter downstream. The exact location is included in commercially available tables, as are the coefficient data based on this style connection.

This connection is not particularly practical when the diameter of the orifice plate is likely to be changed, which requires a re-location of the downstream connection or the introduction of a correction factor to offset the improper location. Difficulty may occasionally be experienced in attempting to locate the connection properly when the beta ratio is small and the pipe pressure rating is high, this requiring a thick orifice flange.

Throat Connections

The throat tap is a sort of "rough and ready" vena-contracta tap. It is located one pipe diameter upstream from the orifice plate and one-half pipe diameter downstream. Reliable coefficient data may be somewhat difficult to find. Certain companies have prepared data, but they are not distributed widely. As an approximation, either flange-tap data or vena-contracta-tap data may be used: the latter is probably the best approximation.

Corner Connections

In this method, the pressure difference is measured at each face of the orifice plate. Corner connections are used extensively in Europe, and are standard in Germany. They have not been widely used in this country because they offer little advantage in larger sizes of pipe and may be a little more expensive to produce. However, the corner connection is more suitable for orifice-type flow measurement in small pipelines (2" and under) than any of the other mentioned varieties. Measurements have been made successfully, particularly in gas flows where the viscosity effect is negligible, in pipe sizes down to ¼". Ordinarily, orifice measurement is frowned upon in the 2" size by most engineers when the flange tap is used. Flow coefficient data with corner connections are available.*

Practical Considerations

In calculating the size of an orifice plate (or the rate of flow through an orifice plate of known dimensions) in accordance with the data contained in the various handbooks, it is important to consider certain points which are often not emphasized sufficiently. These points include (1) the effect of the specific gravity of the liquid being measured on the calibration, (2) effect of density of gas being measured on the calibration, (3) effect of temperature on volumetric readings, and (4) viscosity effects.

Effect of Liquid over Mercury

In liquid flow measurement, the calibration of the meter (how many inches of water differential-pressure will stroke the pen through full scale) will depend on the specific gravity being measured (if a mercury-type meter is used) because the leg of liquid opposite the leg of mercury operates as a counterbalance, partially nullifying the density of the mercury. Therefore, the greater the specific gravity of the liquid being measured, the greater will be the effect on the instrument calibration.

This particular consideration is extensively covered in the general literature. However, where the differential-pressure measuring device, or flowmeter, is of the bellows type instead of the manometer style, the differential-pressure range of the meter is independent of the specific gravity of the liquid being measured. The bellows meter operates on the basis of the force required to displace a bellows whose movement is opposed by a spring mechanism, rather than working on the principle of raising a colum of mercury or water, as is done in the manometer-type meter. As a consequence, the correction for liquid over mercury must be removed if it is incorporated into

*The Barton Instrument Corporation, 1429 S. Eastern Ave., Los Angeles 22, Calif., has a technical bulletin devoted to the use of corner connections for those interested in measurement of flow in small pipelines.

the equation. This is done by multiplying $\sqrt{h}$ by 1.03. Of course, if this correction for liquid over mercury is expressed as a separate factor in the equation used, this factor is simply considered as equal to 1.00.

Gas Density Effect

When a meter is calibrated against a water manometer at atmospheric pressure and then installed on high-pressure gas it will read incorrectly. This is due to the fact that the density of the gas at high pressure is considerably greater than that of air or gas at atmospheric pressure. Therefore, with a given differential across the plate the meter will indicate a greater differential because of the additional unbalanced pressure in the high leg due to the increased density of the gas.

This effect is not the initial zero shift that results from the change in shape of the mercury meniscus, but is an error that increases from zero to full scale. With natural gas (specific gravity of 0.65) in a mercury meter this amounts to approximately 0.2% at 500 psig, 1% at 1800 psig and 2% at 4200 psig.

Flowing versus Standard Volume-Units

Frequently, there may be confusion about the units of flow being measured or desired. An orifice meter measures *weight* units per unit time; the inclusion of volumetric units in the simplified flow equations is based on the assumption that the volume unit, such as a standard cubic foot of gas or gallon of liquid, will weigh a specific amount. In most instances in the process industries gas flow units will be the *standard cubic foot*, which means the weight of a cubic foot of gas measured at standard pressure and temperature (usually 60°F and one atmosphere pressure). However, it is commonly desired to measure the gas in *flowing cubic feet*, that is to say, in relationship to the weight of a cubic foot of gas at the flow temperature and pressure. Appropriate equations are available in the literature for determining flow measurement in either standard cubic feet or flowing cubic feet. The principal requirement is the need to determine which units are desired by the person using the flow information.

It should be remembered that the specific gravity of a gas is independent of the operating temperature. In this way it is quite different than the term "specific gravity" in relation to liquids.

Some industries operate in terms of a gallon measured at 60°F, whereas other industries think of a gallon as 231 cubic inches of liquid without reference to the specific gravity of the liquid at flowing conditions. A gallon of hot oil weighs considerably less than a gallon of oil at 60°. Consquently, the engineer must know whether the rate of flow is to be measured in standard gallons, even though the temperature may be 300° or 400°, or whether the measurement is to be made in gallons of liquid at the flow temperature. Appropriate equations are available for measurement in either of the two ways. The equations are *not* interchangeable, a point that is sometimes overlooked.

The question of whether measurement is handled in standard or flowing units depends on the selection of the proper units of specific gravity, as well as the selection of the proper equation. Specific gravity of liquids may be given either in term of standard temperature (60°F) or in terms of flowing temperature. Conversion of the specific gravity from standard to flowing conditions, or vice versa, can be made easily through the use of standard tables and graphs especially prepared for this purpose.

Viscosity Effects

The viscosity of the liquid whose flow is being measured can vary over broad limits without noticeably influencing flow measurement accuracy. Generally speaking, when the pipe size is greater than 3", a viscosity spread such as would be found between gasoline or liquefied petroleum gas and a light crude oil would affect measurement accuracy only slightly. For pipe sizes under 3", and/or when the viscosity is greater than that of a light crude oil, inaccuracies of 10% to 15% can result if the effects of viscosity are ignored.

The flowmeter usually reads low as the viscosity increases. From a theoretical standpoint, the reading could be low in one region and high in another region; however, as a practical matter, flow measurement is rarely conducted in the section where the reading is high. Therefore, an increase in viscosity usually results in a negative error in flow measurement if the viscosity effect is ignored.

Effects of viscosity are accounted for in flow measurement calculations by determining *Reynolds number*, a dimensionless expression of the relationship between diameter, velocity, specific gravity, and viscosity. As Reynolds number decreases, the correction factor increases.

INSTALLATION FACTORS

Straight Length of Meter Run

An adequate length of straight pipe upstream from the orifice plate is one of the prime requisites for proper installation. All empirical data on which calculations are based were obtained under conditions that would insure a uniform distribution of velocity across the pipe from the side through the center to the opposite side. If the uniformity of the velocity distribution pattern across the pipe is disturbed by fittings upstream of the orifice plate, errors of an unpredictable magnitude occur. The more complex the disturbance, the greater the probable error. For example, two elbows produce more disturbance than one elbow, and a globe valve produces more disturbances than two elbows. Similarly, the higher the velocity in the pipe, the farther downstream from the disturbance is this effect felt. Selection of the amount of upstream pipe based on the velocity in the pipeline is impractical; instead, the selection of the meter run length is determined by the beta ratio and the type of upstream disturbance. Tables and graphs indicating the recommended amount of straight pipe upstream from the orifice plate are available from many sources in the literature.

The flow measurement engineer is frequently called on to estimate the magnitude of error that will result if inadequate upstream piping is provided. Unfortunately, so many variables enter into this picture that it is impossible to predict the effect accurately. All one can say with certainty is that the error will exist, and that it will be negative. In other words, the meter will read low. The magnitude of error can be as much as 10% under adverse conditions.

Locating the Meter

Manometer-type meters must be leveled carefully at the time of installation to avoid difficulty resulting from the float rubbing against the manometer chamber. Flowmeters are generally provided with two liquid-filled leveling tubes placed at right-angles to each other. On the other hand, if the installation is being made wih a bellows-type meter, this factor is not critical.

In selecting a location for the installation of the meter, care should be taken to avoid a location that will permit mechanical vibration to be transmitted to the meter. The effect of vibration can range from the annoyance of a vibrating pen or pointer to serious inaccuracies resulting from ripples in the surface of the mercury and wear in links and pivots.

Also, in selecting a location for the orifice meter it is important that meter chambers be located below the minimum hydraulic gradient. In other words there must be a positive gage pressure in both meter chambers when the system is in operation. When liquids are being metered, it is preferable to have the orifice plate located above the orifice meter; this permits gases or vapors that develop in the meter body to bleed back through the lead lines into the main flow line. For this to be possible, of course, it is necessary that the meter piping slope continuously upward toward the orifice plate; no pockets should be allowed if at all possible. Should high spots in the pipe be unavoidable, it is essential that vent valves be installed to permit the removal of vapors both at the time of start-up and for maintenance.

In gas flow measurement, particularly where the gas is "wet" (that is, contains components which can condense into liquids with a reduction in temperature), the impulse piping must slope *downward* continuously from the orifice meter to the orifice plate. This assumes that the meter is placed *above* the flow line. Similarly, the impulse lines should be ½" in size and shut-off valves should be full-opening type when at all possible. No low spots in the piping can be tolerated. If, on the other hand, the orifice plate must be located above the instrument and the gas is wet, as previously defined, the impulse lines will alternately fill with liquid (when the ambient temperature is low) and be emptied of liquid when the effects of sunlight or other radiant heat raises the temperature of the impulse piping above that of the surrounding air. If the amount of condensation to be expected is small, condensate chambers (Fig. 3) can be installed below the meter body, and fitted with valves through which the accumulated condensate may be drained off. This is only practical, of course, if the condensate chamber of a reasonable size will hold more liquid than is to be expected between normal periods of servicing the meter.

In most instances it is necessary to install *seal pots* (Fig. 3) at an elevation above the orifice plate, and usually adjacent to it, with impulse lines sloping back to the instrument installed as described previously for liquid installations. The meters, the impulse lines, and the seal pots must be filled with a suitable liquid, such as Prestone or a proper variety of oil. Impulse lines between the seal chambers and the orifice flanges should be as short and as near vertical as possible so that condensate accumulating in the seal chamber can be returned to the pipeline.

Length of Impulse Lines

There is a limit on the length of piping between the orifice meter and the orifice plate. When possible, this distance should be kept under 50 feet; if this is impractical, lengths up to 100 feet can be made to work satisfactorily provided at least ½" piping is used and the piping slopes continuously upward from the meter to the orifice plate (or seal pots).

Long lengths of meter piping should be avoided when volatile liquids are being handled. Heat from the sun or other sources of radiant energy can result in vaporization which, by converting part of the liquid in the meter piping into vapor, introduces serious measurement errors.

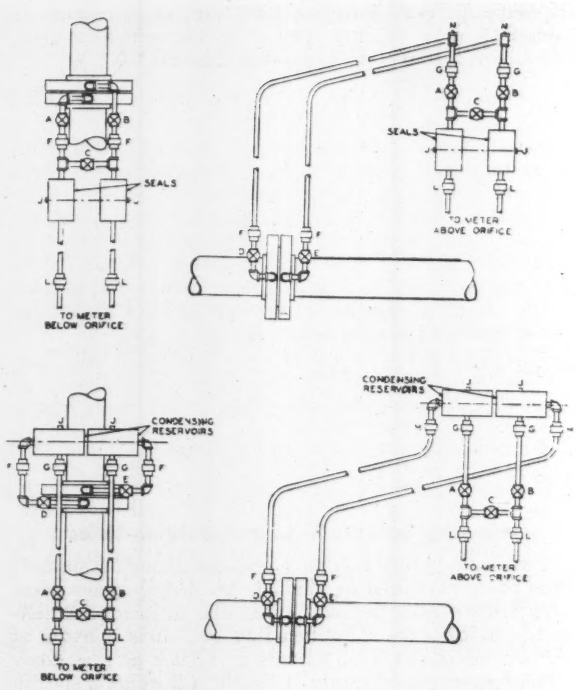


Fig. 3. Typical installations with seal pots and condensing reservoirs.

Location of Pressure Taps

When orifice flanges are being used, the pressure taps should be located at the top of the pipe, or at the side of the pipe, *never at the bottom*. Bottom connections encourage plugging of the meter piping through the accumulation of scale. If pressure taps are being introduced into the pipeline (such as is the case with line taps, vena-contracta taps, or throat taps) it is vital that the inside of the pipe be smooth and free of burrs or other obstructions. Also, the axis of the pressure tap must be perpendicular to the axis of the pipe.

OPERATION FACTORS

Vapor Binding

One of the most common sources of difficulty in the metering of liquids is the presence of air or vapor in the meter piping or the meter chambers. When the system is being started up, vents at the meter chambers should be opened, and with the by-pass valve in the manifold open, both block valves at the orifice flanges should be cracked and liquid allowed to bleed out through the meter chambers until all air has been eliminated. The differential-pressure range of most flow meters is 100" of water or less, so it can be readily seen that a slug of air 8 to 12 inches long in a vertical run of meter piping can introduce a serious measurement error.

One word of caution in venting the meter should be sounded in regard to the metering of hot liquids. Under such circumstances the meter piping and the meter should be filled with cold oil before the start-up time if at all possible. If this is impractical, provision should be made in the meter piping, adjacent to the meter, to permit the

hot liquid to be bled out of the meter piping without being carried through the meter chamber.

Wet Gas

When gas is being measured, particularly if condensate or other liquid may enter the system, certain difficulties can be encountered even when the meter is located above the orifice plate. In a mercury meter, condensate will accumulate in the meter chambers above the mercury. This will act as a partial nullifier of the density of the mercury, and flow measurement must be corrected as described earlier. In cold weather, water condensed on the top of the mercury can be converted into a substance similar to snow, which is known as *gas hydrate*. This substance forms at temperatures considerably above freezing when the pressure is sufficiently great. For example, at pressures in the neighborhood of 3,000 to 4,000 psi, gas hydrate can be produced at temperatures as high as 80°F. Gas hydrate can also form in elbows or valves in the impulse piping, rendering the instrument inoperative—as will be true also when hydrate forms on the surface of the mercury.

The most practical solution to the problem of gas hydrate, if water vapor cannot be removed from the gas before measurement is made, is use of a meter housing with a heater to keep the impulse piping and the meter warm. Although bellows-type meters do not suffer from the effects of gas hydrate formation within the meter body itself, as occurs with a mercury-type meter, presence of gas hydrate in the impulse lines is an annoyance and may render the meter inoperative if the lines become completely plugged.

Start-Up

When the system is being put into operation, care must be taken to avoid over-ranging either manometer-type flowmeters or single-bellows-type flowmeters. An appreciable overload across the measuring element will result in loss of mercury in the former or bellows distortion or rupture in the latter, either of which will interfere with measurement and require maintenance or expensive repairs to return the meters to operational condition. (This does not apply to the rupture-proof dual-bellows-type flowmeters, although even there it is desirable to avoid unnecessary over-range.) Over-ranging the instrument at the time of start-up can be avoided if the by-pass valve is completely open and the block valves are slowly opened simultaneously.

If the meter is accidentally over-ranged, the block valves and the manifold should be closed, and with the bypass valve completely open, the zero position of the meter should be checked. If it does not zero out as it did before start-up was attempted, mercury has been lost, or, in a single bellows meter, a bellows has been damaged. In either event, an overhaul will be required.

Bearing Lubrication

For satisfactory operation, instruments fitted with a pressure bearing must be given periodic lubrication. Absence of lubrication will not only result in leakage of the product into the instrument case, but may also induce friction in the pressure bearing with a subsequent loss in instrument accuracy.

Meter Accuracy

In considering the performance of a flowmeter installation, care should be taken to distinguish between accuracy and repeatability. The flow measurement engineer frequently is called upon to state the accuracy of the system when actually the inquirer is interested in repeatability.

In establishing the accuracy that can be attained, several elements must be considered—the accuracy of the primary element, the accuracy as related to the primary element installation, and finally the accuracy of the secondary element, or flowmeter. The accuracy of the system is a combination of all three.

The empirical data published for flow coefficients vs. beta ratio is accurate to probably ½ of 1%. There seems to be evidence to indicate that the coefficient will wander, even if the flow is held steady, to perhaps ¼ of 1%.

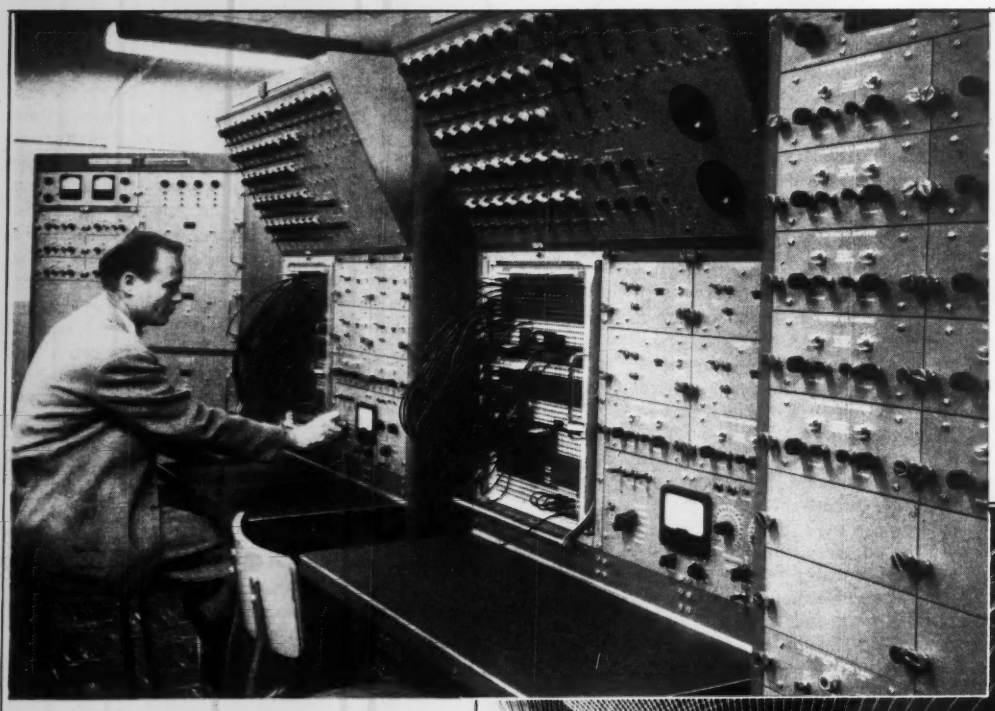
As discussed earlier, the run of straight pipe ahead of the orifice plate is most important because it can affect over-all accuracy to as much as 10% under adverse conditions. Also, the reliability of the data used in computing the orifice bore, such as specific gravity of the liquid, is important. For relatively small changes in specific gravity, one can consider that the error in flow measurement will be about one-half as much, percentage-wise, as is the percent change in specific gravity. Similarly, if the installation is such that viscosity has an important effect, stability of viscosity will affect the accuracy of flow measurement. In gas measurement, variations in temperature, pressure, or specific gravity will introduce significant errors.

Manufacturers ordinarily put an accuracy guarantee on the flowmeter of from ½ of 1% to 1% of the differential-pressure range. Ordinarily, however, the accuracy of differential-pressure measurement does not allow for the effects of increased pressure on instrument performance either in relationship to changes of the mercury meniscus or binding of the pressure bearing shaft under operating conditions. The shape of the mercury meniscus may also be affected by the presence of certain contaminents in the meter chambers.

The effects of meter-body temperature variation on instrument accuracy can be severe with certain apparatus. Changes in calibration of the order of magnitude of 3 to 3½% of instrument range per 100 F degrees change in meter-body temperature can be expected with mercury-type meters, and with some bellows-type meters or diaphragm-type transmitters as well. Bellows-type meters with temperature-insensitive range springs are available which reduce this error to less than ½ of 1% per 100 F degrees.

In gas-flow measurement reasonably accurate results cannot be expected if the gas flow is of a pulsative nature, within present state of knowledge in the art. Although some forms of meters seem to give better results than others, the fundamental fact remains that the orifice plate, itself, cannot generate a differential-pressure signal that follows the conventional relationship with flow when the gas is pulsating. A description of what actually happens adjacent to the orifice plate could be the subject of an extensive paper in itself. The conditions, under pulsative flow, are complex. There is, however, some indication that a further refinement of Bernoulli's theorem will permit accurate prediction of flow rate under pulsative conditions. Before this can be done, extensive additional research is required. For the present it is safe to say that gas measurement under pulsative conditions cannot be accurate.

Generally speaking, under common conditions, over-all accuracy of flow measurement may approach 1%. If common variations can be reduced to a minimum, the accuracy figure may be something like ¾ of 1%. However, under ordinary industrial conditions, the range of accuracy probably lies between 1½ and 3%.



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North American Aviation, Inc.

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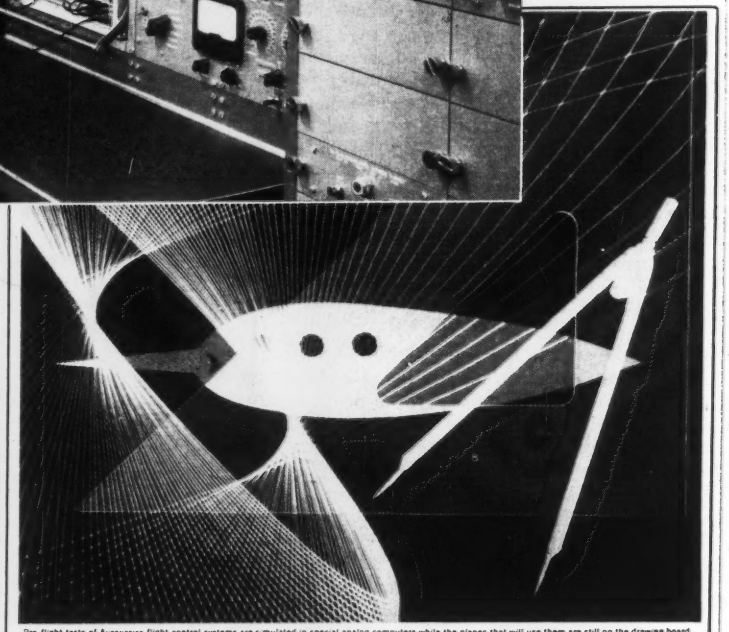

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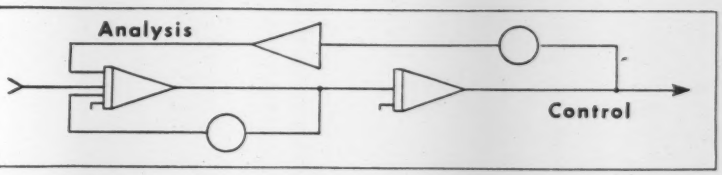
The SIMULATION COUNCIL Newsletter



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Southeastern Simulation Council
W. K. McGregor, ARO, Inc., Tullahoma, Tenn.; Chairman, Steering Committee.

My Word!

When we used to sail on Lake Pontchartrain and occasionally became becalmed, we would scratch the mast and whistle. This was known as "whistling up a breeze." Usually the only breeze was the direct result of our whistling, but one time I tried it and conjured up a squall that nearly swamped us all before we could take in sail. I had apparently under-estimated the power of my sorcery.

More recently your Editor underestimated the power of our *Newsletter*. I intended only to whistle up a little concrete information by reflecting in my February *Instruments and Automation* article some of the skepticism I detected at the January Western Simulation Council discussion of high-performance analog-to-digital-digital-to-analog conversion equipment. Instead I raised a storm of protest! But I also got the information—in no uncertain terms!

Therefore, I had intended in this space to give you the word as received from one who should know, Mr. Bernard Gordon, President of Epsco, Incorporated, 588 Commonwealth Avenue, Boston 15, Massachusetts, and to wish Epsco and all other pioneers in this vital field all possible success. However, as Milt Aronson has done a very adequate job of that in his editorial on page 683, I will not repeat Mr. Gordon's facts here.

Anyway, we got the info we wanted on Epsco. And our tempest in a newsletter also underscored two additional facts:

1. Some people read the *Newsletter*.
2. Some people take it seriously.

Bits

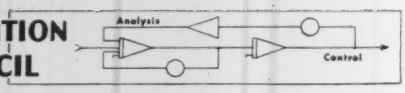
Saw *John Strong* of EA at the Louisiana State University High-Speed Computer Conference, and he mentioned the use of analog computers for Linear Programming. I was interested because I had had an instinctive feeling that it would be possible, but had neither the knowledge of Linear Programming nor the time necessary to try it. So at my request John sent me a paper on the subject: "Linear Programming on an Electronic Analog Computer" by *I. B. Pyne* (Princeton University, Princeton, N.J.) which was presented at the AIEE meeting in New York (January 30-February 3 of this year). I had hoped to review the paper in this space but gee, I find I can't even read it, much less write about it! Would appreciate a translation and condensation from one of my better-informed readers. I'll print it with credit if I can understand it!

More in my line was "Substitution Methods for the Verification of Analog Solutions" by *Hans Meissinger*, presented at the National Simulation Conference in Dallas (January of this year). Here I can quote Hans' own abstract:

> "Substitution of analog computer solutions into the original differential equations followed by an iterative or a variational procedure can be employed as a practical verification technique and as a method for improving solution accuracy. The method has the advantage of utilizing information contained in the analog solution and, therefore, yields results more rapidly than the conventional procedure of deriving an independent numerical check solution. It is also valuable as an aid in locating the source of computer errors.
>
> "Theoretical and practical aspects of the substitution check method are discussed and illustrative examples are presented in this article."

Jack Rudolph (Goodyear Aircraft Corp., Akron, Ohio) writes reminding us that issues of the *Newsletter* dated March and April '53 carried a suggested specification form for electronic multipliers. Apparently our specs called for too much info, 'cause heretofore no manufacturer has specified his multiplier as we suggested. However, Jack enclosed four pages of specs (plus gain, phase shift and static accuracy plots) patterned after the detailed form which *Dick Baum* (Goodyear Aircraft, Litchfield Park, Ariz.) had worked out for the March '53 *Newsletter*. Wish we had room to print it in its entirety as it certainly gives the dope on the new GEDA N3A Electronic Multiplier, but I suppose Jack would be willing to send you copies on request.

SIMULATION COUNCIL



We also received some information on the new Goodyear A-14 GEDA which seems to embody some very desirable and intriguing new features. We await detailed specs with interest.

And on the subject of new computers, we find that Weber Electronics (2820 Ontario St., Burbank, Calif.) has, with the utmost secrecy so far as we are concerned, come out with a desk-type analog computer with 24 stabilized amplifiers, some nonlinear equipment, and a unique problem setup system complete with power supplies for about $8k. We know nothing more about it but will see what we can find out.

* * *

The Eastern Simulation Council has decided to supplement their bimonthly meetings with study groups to bring more members into active participation in the ESC; to provide a source of topics for regular council meetings; and to provide a source of material for training new people.

Five study groups have been set up as follows:

Subject & *Chairman*:

1. System Design Using Computers—*H. Wexler*, Sylvania Electric Products, Missile Systems Laboratory, 100 First Street, Waltham 54, Mass.

2. Analog Recording—*Jules Lehman*, Radio Corporation of America, Princeton, New Jersey.

3. Dead Time Simulation—*B. Loveman*, Reeves Instrument Corp., 215 E. 91st St., New York 28, N. Y.

4. Use of Noise in Simulation—*R. R. Favreau*, Electronic Associates, Inc., Princeton Computation Center, P.O. Box 582, Princeton, N. J.

5. Single Amplifier Transfer Functions—*H. Mori*, DACL, Massachusetts Institute of Technology, Cambridge 39, Mass.

Anyone wishing to volunteer for a study group should get in touch with the Chairman. This sounds like a swell idea—we will all watch their progress with interest.

* * *

And the Southeastern Simulation Council has started its own Newsletter, the first issue of which: gives the program for the next meeting; sparkplugs a deep-sea fishing trip; tells of a plan to have a Steering Committee representative from each organization; describes the cooperation of *Instruments and Automation* which makes it possible for Simulation Councils to raise money without dues (by subscribing to *I&A* through the Council—order blank enclosed); has a paragraph on Southeastern Simulation Council participation in the National Simulation Conference; asks members to prepare themselves for discussion at the coming meeting; and requests members to fill out a form which is furnished to get a better idea of the SSC people, their work and their interests.

The second issue (March) is along the same lines and should certainly stimulate and maintain interest.

* * *

We have another letter from *Lou Wadel* (Chance Vought, Dallas, Tex.) who did such an outstanding job in connection with the National Simulation Conference in Dallas. Lou included a list showing the geographical distribution of registrants (not including speakers or session chairmen) at the Conference. We found it interesting—what do you think?

State	*Registrants*
Texas	87
California	66
New York	55
New Jersey	20
Ohio	20
Michigan	16
Pennsylvania	14
Massachusetts	13
New Mexico	13
Washington	12
Maryland	11
District of Columbia	9
Connecticut	7
Delaware	6
Georgia	6
Illinois	5
Kansas	5
Indiana	4
Oklahoma	4
Wisconsin	4
Missouri	3
Alabama, Florida, Iowa, Minnesota, Tennessee, Virginia—each	1
Canada	6
England	1

* * *

We also have a letter from the IRE signed by our friend *Rawley McCoy* (Reeves Instrument Corp., New York, N. Y.) which says in part: "You probably know that there is available a medium for formal dissemination of information on analog computer developments, the *Transactions on Electronic Computers* published by the IRE Professional Group for Electronic Computers. Unfortunately, this medium has been sadly neglected as a source of useful information relating to the analog computer field. To correct this deficiency, the Publications Committee for the *Transactions* is attempting to increase the scope of the publication, particularly with regard to papers dealing with analog computers."

"The Publications Committee does not intend that the *Transactions* shall replace other less formal publications, such as the *Simulation Council Newsletter;* rather, it wishes to supplement* them with a somewhat more formal journal for the dissemination of information pertaining to computers, both analog and digital."

"The Publications Committee has asked me to solicit papers for a special issue, presently scheduled for September 1956; it will deal exclusively with check methods for analog solutions and the applications (or tie-ins) of digital equipment with analog computation. Perhaps you, or members of your staff, have done work in these fields which would justify a paper in the *Transactions*. If such is the case, we would certainly like to hear about it."

"As soon as a suitable paper is available for review, three copies should be forwarded to me . . . In order to be acceptable, papers must be received before the 5th of June.

Rawley D. McCoy
Reeves Instruments Corporation
215 *East* 91*st St.*
New York 28, *N. Y.*

* * *

As we have frequently expressed concern about the technical educational situation in general, and have heard people cry in alarm about displacements which will result from automation in particular, we were interested to see the following under "Comment" in Canning, Sisson and Associates' *Data Processing Digest* for January of this year:

> "Since 'automation' may begin displacing unskilled and semi-skilled people in the near future, the Los Angeles Adult Education system has initiated a course for training such persons as electronic technicians. The course totals 720 hours of instruction (theory and lab), over eight terms. Classes are limited to 15 students each, to provide

*This fits in perfectly with the Simulation Council objective of supplementing rather than competing with the work of existing organizations.

adequate question periods and laboratory participation.

"Based on a survey, the 'typical' student taking this course is 36 years old, married, has two children, is in factory production in a manufacturing plant employing 500-3000 people in an unskilled or semi-skilled capacity, and has had two years of high school education.

"The course is based on the premise that the advent of automation will demand more electronic technicians. It has been organized to provide new jobs for persons displaced by automation, as well as to allow people to up-grade their skills in an expanding electronics industry."

* * *

We have in the past been so intrigued by the meanderings of our friends in and around the field of Simulation that we think it would be interesting to try to keep up with some of them. We therefore solicit any info you care to give us concerning personnel changes you or your friends make or know of.

As a starter we will mention three people we have seen recently representing different organizations:

Bob Bemer is now with IBM, New York City

Jim Helfrich is with the G. S. Marshall Company

Niels Christensen has gone with Ramo-Wooldridge.

Control Engineering for January '56, in an article on John R. Ragazzini, "A Control Personality" says: "A part of this development was a simulator of a human being in a tracking situation." Now as we have written (*Newsletter* in the December '55 *I&A*), *John Stroud* (Navy Electronics Lab, San Diego) has voiced some very strong opinions (in a way that made us feel that we knew what he was talking about) to the effect that you can't simulate "homo sap" at all satisfactorily. But we have Goodyear's Report GER-6608 "Application of GEDA to Human Dynamic Studies" by *R. J. Mead* and *N. Diamantides*, the abstract of which states in part ". . . a successful experiment is described, wherein the pilot, without his knowledge, is replaced by a nonlinear pilot analog." Looks as if this subject leaves room for discussion!

* * *

We have just sent out one of our last dollars "to be certain to receive the next four issues of *A Gateway to Science,*" E. C. Berkeley's new publication, because that science business is a racket we'd sure like to get into and now it looks as if the price is about right!

Pieces

Laura, our old colored maid-of-all-trades in New Orleans, used to say of her often out-of-work husband's continual borrowing, " 'At man jus' two-bit me to death!"

And that is just what I have done to your *Newsletter* this month; I have so many "Bits" that there is not space left to do justice to Bernie Loveman's talk or the discussion which followed on "Electromechanical and Electronic Means for Multiplication, Function Generation, and Resolution" at the Western Simulation Council meeting at Firestone Guided Missile Division on 8 March. Therefore I will only give you the following tabulation of the subjects Bernie covered and say "to be continued next month—don't miss the final thrilling episode!"

OPERATION	SERVO	ELECTRONIC
Multiplication	Single-Turn Potentiometers Multiturn Potentiometers	Time Division Quarter Square Law AM-FM
Function Generation (Single Variable)	Tapped Potentiometer Cam Potentiometer Functional Potentiometer	Diodes Photoformer
Function Generation (Two or more Variables)	Tapped Potentiometer Three-Dimensional Cam (MIT) Conducting Surface (Teledeltos)	Diodes PHOSIAC
Resolution	Sine-Cosine Potentiometers Induction Resolver	Function Generators and Multipliers
Continuous Resolution	Resolver and Rate Servo Resolver and Switching Servo and Sine Wave Generator	Resolver and Electronic Switch Electronic Multiplier and Sine Wave Generator

Thots

Dr. Simon Ramo as quoted in *Western Electronic News* for March, 1956:

"Anyone brave enough to challenge the idea that in a few years the replacement of man's brains will be the top industry of the nation is in danger of having his brains amongst the first to be replaced."

General Leslie Groves at the LSU High-Speed Computer Conference, speaking of those who are alarmed by the changes automation portends:

"Did the motor industry change the buggy too much?"

Computer Events

Other events on page 655

Western Simulation Council

Date: May 10, 1956

Place: Aerojet-General Corp., Azusa, Calif.

Time: 1:00 PM—Steering Comm.

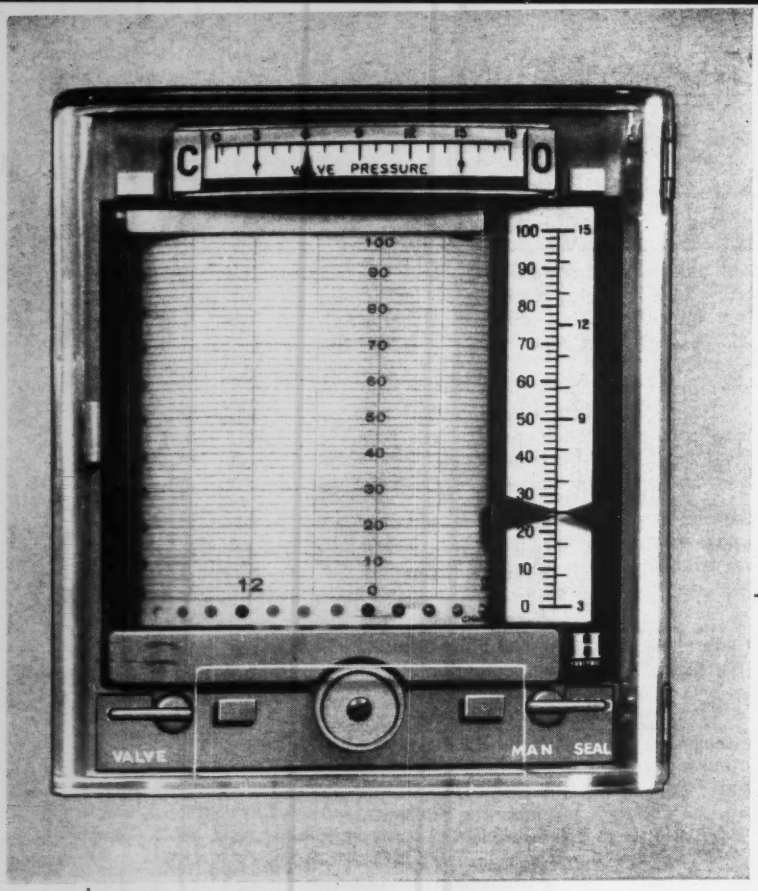
1:30 PM—General Meeting. "Control Console Design and Centralized Control for Analog Computers"—Speakers will be Norm Irvine of Aerojet and Joe Hussey of Berkeley Division, Beckman Instruments.

The meeting will be unclassified, but Norm would like advance notice of those who plan to attend the meeting, if possible.

Midwestern Simulation Council

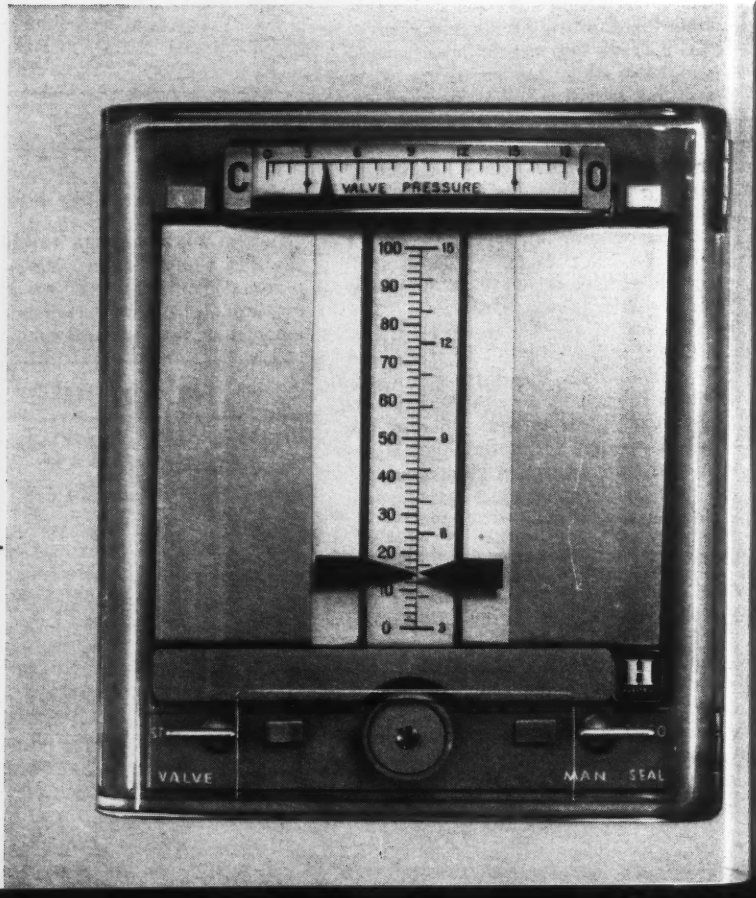
Date: May 15, 1956

Place: Battelle Memorial Institute, Columbus, Ohio. For information write J. J. Stone at the Institute.



for simplest

Both the *Tel-O-Set* indicator and recorder have vertical indicating scales on which large, opposing pointers clearly show measured value and set point. The control knob and transfer switches are located near the bottom of the case, where they can be manipulated without the operator's hand obscuring the view of the pointer and scale.



● **REFERENCE DATA:**

Write for Bulletin 7202.

Design your instrumentation

installation, startup, service

-with *Tel-O-Set* instruments

The exclusive features designed into *Tel-O-Set* miniature instruments save you time, trouble and money . . . from the instant these instruments are installed on your control panels.

Easy installation. The indicating and recording chassis is a complete assembly that can be supplied separate from the case. Since the case contains the valve pressure gage and pressure regulator, you can install it in the panel, make complete piping connections . . . and then insert the instrument chassis later, at startup.

Foolproof startup. Because it can be shipped separately, the chassis is protected against dirt and damage until it is ready to begin service. Air lines can be checked, control valves stroked and final inspection made *before* the chassis and controller are installed.

Serviced in seconds. Down-time for instrument maintenance is eliminated, for a complete chassis can be replaced in just a few seconds. There is no loss of control during replacement . . . no disturbance to electrical connections. To adjust zero and span, or to inspect parts, you can partly withdraw the chassis from the case, without interrupting operation.

Tel-O-Set instruments can handle a broad range of temperature, pressure, flow and liquid level applications. They work with any type of pneumatic force-balance controller. They are sensitive and accurate . . . have true linear calibration . . . respond instantly to changes in measured variables. For a discussion of how you can use them profitably, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

H HONEYWELL

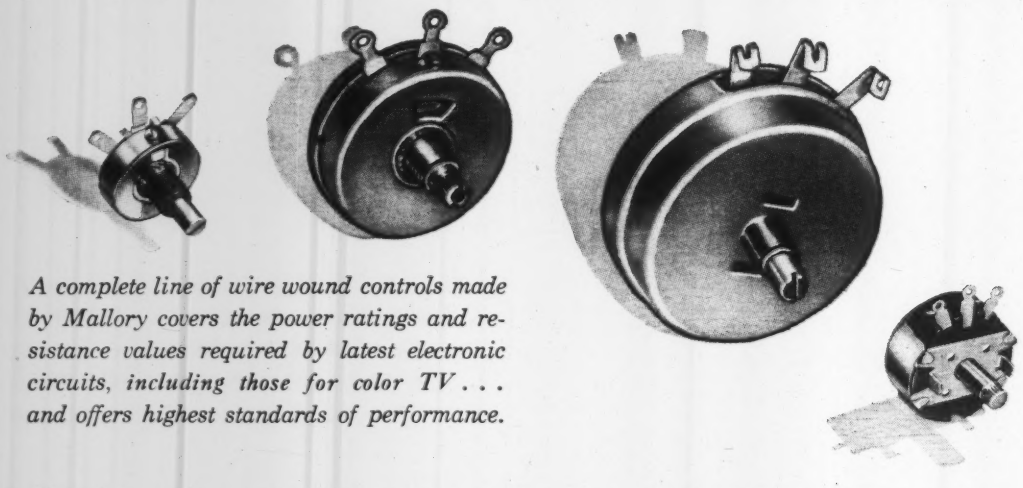
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

For more information circle 63 on inquiry card.

MALLORY



A complete line of wire wound controls made by Mallory covers the power ratings and resistance values required by latest electronic circuits, including those for color TV . . . and offers highest standards of performance.

Wire wound controls with the ratings, resistances and reliability you want

Mallory
Wire Wound Resistors
for heavy duty service

A comprehensive line of vitreous enamel power resistors made by Mallory meets the requirements of many electrical and electronic circuits where high power dissipation is needed . . . in voltage dividers, bleeders, load or shunt resistors.

Mallory resistors are space-wound on high quality steatite cores, using large gage wire with matched temperature coefficients of all parts. They are designed for maximum heat dissipating area, to assure cool operation. A special non-porous, non-alkaline vitreous enamel coating gives effective protection of the winding.

Fixed and adjustable types are available in ratings from 5 to 200 watts. Write for data.

When your new circuit designs call for controls with higher power dissipation, plan to use the dependable, trouble-free performance that you can get with Mallory wire wound controls. These are true precision products, made to exacting standards to guarantee complete uniformity and adherence to specifications on every control you receive.

The Mallory line of wire wound controls includes a broad range of designs, wattage ratings and resistance values. All ratings are conservative . . . no need to over-design to allow for extra safety. You can choose from models with insulated or grounded rotors . . . all fitted with standard ⅜″ mounting bushing and short screwdriver-slotted shaft. The following types are available:

Model	Watts	Resistance range—ohms	Rotor connection
R	2	1- 20,000	insulated
C	2	½- 15,000	grounded
M	4	½-100,000	insulated
E	7	3-150,000	grounded

For complete information, write to Mallory today for Technical Bulletin. A Mallory control specialist will be glad to lend personal assistance on your commercial or military applications.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

For more information circle **64** on inquiry card.

Announcing the top Automation Education Program of the Year
—100 CLINIC CLASSES

AUTOMATION promises wonders for the future—but today there is a lack of trained manpower—there are not enough men available who are trained to work and think in the area of automatic production.

Manufacturers of automatic controls are faced with this problem in the application of their products in industry. Industrial executives cannot spare their engineers and production men the time to attend colleges and universities. Now—for the first time—a complete educational lecture-demonstration program is offered as a solution to these problems.

The Automation Show Management therefore offers

100 CLINIC SESSIONS

in conjunction with the THIRD INTERNATIONAL AUTOMATION EXPOSITION, November 26-30, 1956, New York, in the fields of

(1) Electronic Computers
(2) Process Automation
(3) Machine Tool Automation
(4) Office Automation
(5) Automatic Materials Handling (conveyors)
(6) Servomechanisms
(7) Electromechanical Components
(8) Electronic Components

Each clinic class will comprise a 90-minute *lecture and demonstration* based on *operating equipments* exhibited at the Exposition.

Each registrant can sign up for six clinic sessions in one (or more) of the eight basic fields.

For example, registrants to the Computer Clinic of the Second International Automation Exposition chose six of the following nine classes:

1. The Austin Co. (special-purpose computers)
2. Clevite-Brush (TapeDrum data handling)
3. Bendix Aviation (digital differential analyzers)
4. Berkeley-Beckman (analog computers)
5. Goodyear Aircraft Co. (analog computers)
6. Electronic Associates, Inc. (analog computers)
7. International Business Machines (digital data processors)
8. Librascope, Inc. (digital computers)
9. Teleregister Corp. (Magnetronic data systems)

Fill in card for early registration. Only 200 persons can be accommodated for any one field—for example, only 200 persons will be accepted for the computer clinic. Early registration is advised. Fee is $10.00 for six sessions. Each registrant will be given a choice of six sessions from the 100 available.

These clinic presentations will be at the applications level and thus instruct engineers, research men and technicians to specify, apply, and operate the components and equipments now available for plant, factory, laboratory and office automation.

Each clinic will consist of one 90-minute lecture and demonstration, by each of the participating firms, to a class of 30-35 registrants. This session will be delivered up to six times in order to ultimately reach the 200 registrants that will be accepted for any one clinic.

Third International Automation Exposition, Advance Clinic Registration
845 Ridge Ave., Pittsburgh 12, Penna.

Please expedite my registration for six clinic classes.
Attached is my $10 registration fee ☐. Please send more details ☐.

I prefer them to be in the field of .....

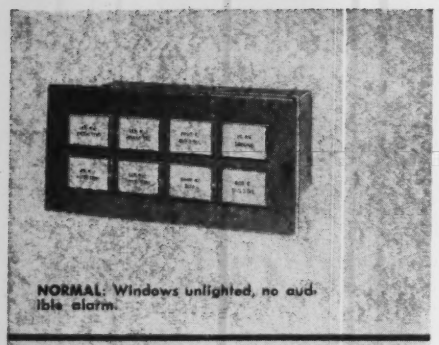
or divided between the fields of .....

Name .....

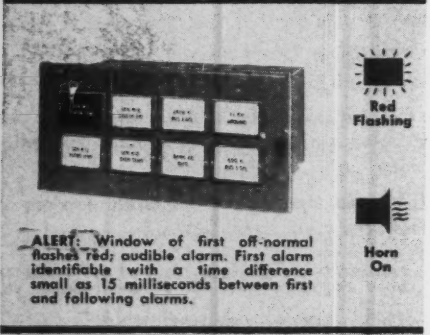
Company ..... Title .....

Address .....

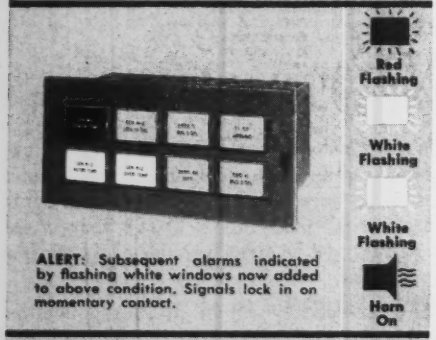
Products Manufactured .....



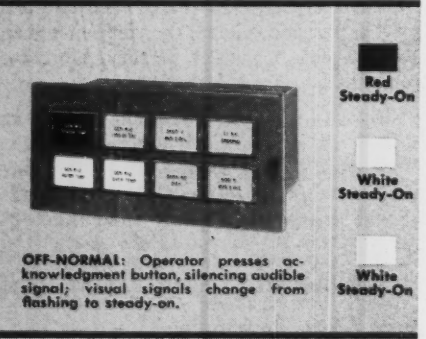
NORMAL: Windows unlighted, no audible alarm.



ALERT: Window of first off-normal flashes red; audible alarm. First alarm identifiable with a time difference small as 15 milliseconds between first and following alarms.



ALERT: Subsequent alarms indicated by flashing white windows now added to above condition. Signals lock in on momentary contact.



OFF-NORMAL: Operator presses acknowledgment button, silencing audible signal; visual signals change from flashing to steady-on.

NORMAL AGAIN: As conditions return to normal, white windows drop out, original red signal remains until reset button is pressed.

Panalarm "VS" Annunciator identifies first off-normal from subsequent alarms for rapid corrective action

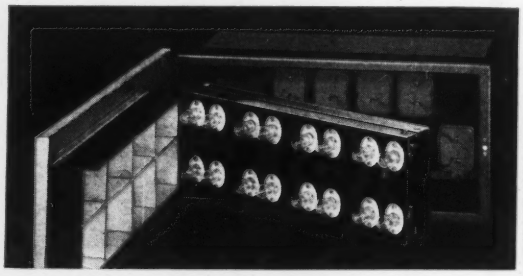
You gain the control advantages of an audio-visual information system, not just an alarm system, with the Panalarm "50VS" Visual Sequence Annunciator. This is particularly valuable when one off-normal condition will cause a "chain-reaction" of off-normals. Typical Panalarm applications are found in the process industries and among users of automatic machinery.

The original off-normal is clearly identified, enabling the operator to take immediate, corrective action. A considerable saving in down-time can often be effected simply by knowing the original source of trouble.

Panalarm "50VS" is completely flexible in setting up various sequential groups. Any number or combination of signals may be grouped as an independent sequence, and the groupings may be changed at any time by simple jumpers on the terminal block. Signals may be either illuminated nameplate or bullseye indicators, combined with a horn, bell or other audible signal. Signaling is simple and positive. A typical sequence is illustrated on the left.

Write for literature on the "50VS" and other Panalarm Annunciator Systems. A Panellit sales engineer will be happy to make a survey of your production operation to determine whether a Panalarm system can help increase efficiency and safety in your plant.

All Panalarm Annunciator Systems are completely modular, permitting future growth and changes. The photographs below illustrate a typical Panalarm Cabinet with illuminated nameplates and the hermetically sealed Panalarm "50" plug-in relay unit. Components throughout are ruggedly built to instrument standards for continuous, dependable duty. Entire Panalarm system is suitable for Class 1, Division 2 installations.

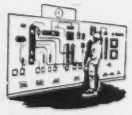


Listed by Underwriters' Laboratories

U.S. Patent No. Re-24,031

Engineered Information Systems for Industry

Panalog Information Systems



Graphic Panels Control Centers

Instrument Services Division

PANALARM

Division of

PANELLIT, INC.

7405 N. Hamlin Ave.

Skokie, Ill.

Panellit of Canada Ltd. Toronto 14

For more information circle **66** on inquiry card.

INSTRUMENTS and AUTOMATION Films

WHEN the publisher of *Instruments & Automation* was executive secretary of the ISA, he prepared a list of motion picture films of interest to groups in the field of instrumentation. The following list of films can be considered a supplement to this original list (obtainable from the ISA). Lists of other films can be obtained also from the ASME.

THE GLASS CENTER OF CORNING
Color, 16mm., sound, 25 min.
Review: This is a visit to the world of glass at the Corning center.
Source: Association Films, 347 Madison Ave., New York 17, N. Y.
Avail: Loan, pay return postage.

HOW A WATCH WORKS
Color, 16mm., sound, 20 min.
Review: This film shows what makes a fine watch tick, with shots "inside a watch".
Source: Association Films, 347 Madison Ave., New York 17, N. Y.
Avail: Loan, pay transportation costs.

NEW HORIZONS IN ALUMINUM BRAZING
Color, 16mm., sound, 22 min.
Review: The film describes the advantages that brazing provides in the design and fabrication of aluminum products.
Source: Motion Picture Section, 854 Alcoa Bldg., Pittsburgh 19, Penna.
Avail: Loan

MODERN MINING
Color, 16mm., sound, 20 min.
Review: The film features action scenes of Thor machinery at underground properties of the Colorado School of Mines.
Source: Thor Power Tool Co., Aurora, Ill. or branch offices.
Avail: Loan

TECHNIQUES OF SURFACE GRINDING
Color, 16mm., sound, 31 min.
Review: This film presents new techniques of precision surface grinding—illustrates high production with automatic machines.
Source: The DoAll Co., 254 North Laurel Ave., Des Plaines, Ill.
Avail: Loan

FILM OF AIR SHOW AT FARNBOROUGH, ENGLAND
Color, 16mm., sound, 20 min.
Review: The film covers engine displays and flying exhibitions at the annual Farnborough show, sponsored by the Society of British Aircraft Constructors.
Source: George A. Starbird, Meletron Corp., 950 North Highland Ave., Los Angeles 38, Calif.
Avail: Loan

THE STORY OF LIGHT
Color, 16mm., sound, 10 min.
Review: This film, featuring the stop-motion puppet technique, progresses through man's attempts to harness fire to the magic of modern lighting.
Source: General Electric, 535 Smithfield St., Pittsburgh 22, Pa. or any General Electric film library.
Avail: Loan, pay return transportation cost.

AUTOMATION
Color, sound, 9 min.
Source: Public Relations Director, Admiral Corp., Chicago 47, Ill.
Avail: Loan

DYNAMIC MEASUREMENT
Color, 30 min.
Review: The film tells the story of 20th Century "electronic yardsticks" that have replaced man's former measuring tools, and demonstrates the role of dynamic measuring and recording instruments in science, industry and medicine. Winner of Oscarette at 1954 Cleveland Film Festival.
Source: Frank A. Jones, Public Relations, Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.
Avail: Loan

FLUID MIXING
Color, 16mm., sound, 30 min.
Review: This film shows how process efficiency is improved by the advanced mixing techniques now available to industry.
Source: Mixing Equipment Co., Inc., 224 Mt. Read Blvd., Rochester 11, N. Y.
Avail: Loan

MECHANICAL ENGINEERING
Color, 20 min.
Review: The film shows scenes of training at Michigan State College, and engineers at work in Michigan industrial plants.
Source: Department of Information Services, Michigan State College, East Lansing, Mich.
Avail: Loan

BASIC ELECTRICITY
Color, 16mm., sound, 22 min.
Review: This Walt Disney production presents fundamental terms and theory of electricity in cartoon style.
Source: Minneapolis-Honeywell, The Tower Press Bldg., 1900 Superior Avenue, Cleveland 14, Ohio.
Avail: Loan, pay return transportation, allow 2 weeks notice.

world's largest turbine-powered transport helicopter
...designed and built by Piasecki
...uses Statham Accelerometers to gather invaluable test data
Statham LABORATORIES
12401 W. Olympic Blvd., Los Angeles 64, Calif.
For more information circle 67 on inquiry card.

INSTRUMENTS and AUTOMATION

New Instruments

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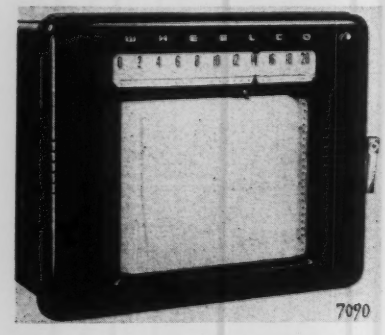
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 809

PROCESS MEASUREMENT and CONTROL

POTENTIOMETER OR BRIDGE RECORDER-CONTROLLER

New "Series 8000 Electronic Potentiometer-Recorder," of self-balancing type, is available in a wide range of models for temperature, speed, strain,

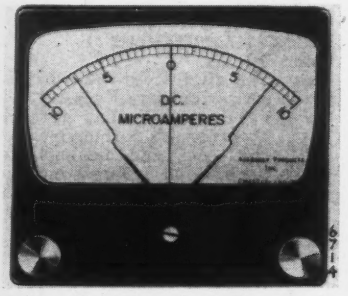


pH, etc. Accessibility and easy adjustment: outer door swings open 180°; both chart rolls and chart-and-drive assembly swing out 180° the opposite way; prestandardized calibrated slidewire remains in positive contact at all times. Wide selection of standard scale ranges (which can be changed without changing slidewire). Amplifier chassis uses plug-in components with standard electron tubes readily available anywhere.—*Wheelco Instruments Div., Barber-Colman Co., Rockford, Illinois.*

For more information circle **201** on inquiry card.

ELECTRIC-CONTACT-TYPE AUTOMATIC CONTROLLER

New "Model 461-C Contact Meter-Relay" has one contact carried on moving element, the other on adjustable pointer. Since torque of moving coil alone is too low for reliable contact operation, a locking coil, integral

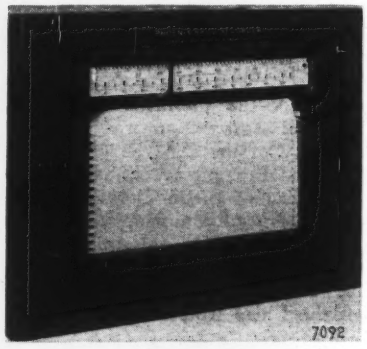


with moving element (it is wound on top of moving coil) develops additional torque to drive contacts together with a pressure of 1 to 3 grams. Reset can be manual or automatic. Contact arrangements: single high, single low, or double (both high and low). Ranges can be supplied either ac or dc, except low millivolts which come only in dc because of limitations of instrument rectifiers.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **202** on inquiry card.

RATIO RECORDER

New dual-purpose recorder has lower scale (for normal recording) graduated 0 to 100 over central 10";



upper scale (for ratio recording) graduated 0 to 100 over full 11". With selector switch in "ratio record" position, recorder will automatically ratio any two dc signals and trace a continuous ratio recording with a single pen. Reciprocal of ratio can be read at any time by reversing recorder inputs. Outputs from electrical pickups for pressure, temperature, force, etc., can be ratioed. Available with standard chart speed ranges, or in special *X-Y* versions. Also special ac versions for ratioing power-line-frequency signals.—*Phoenix Precision Instrument Co., Inc.*, 3803-05 *N. Fifth St., Philadelphia* 40, *Pa.*

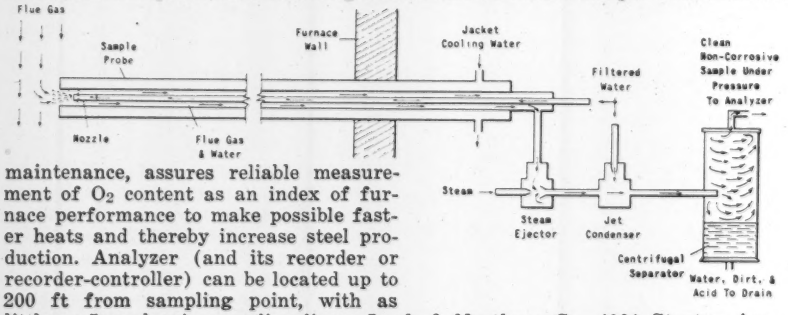
For more information circle **203** on inquiry card.

PLUG-IN CONTROLLERS

New "plug-in" instrument housing, applied at factory or furnished in kit form to be installed by user, is for continuous processing where qualified maintenance personnel are generally not available on all shifts and where, in event of instrument lapse, controlled equipment would normally be out of production. It permits inexperienced personnel, without knowledge of wiring or instruments, to replace complete temperature controller promptly

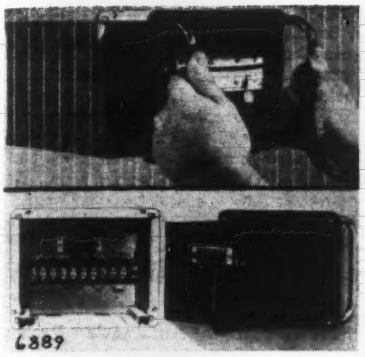
SAMPLING SYSTEM FOR CONTINUOUS MEASUREMENT OF O_2

New gas sampling system for use with maker's magnetic type oxygen analyzer solves difficult problem of obtaining a continuous dirt-free sample with minimal



maintenance, assures reliable measurement of O_2 content as an index of furnace performance to make possible faster heats and thereby increase steel production. Analyzer (and its recorder or recorder-controller) can be located up to 200 ft from sampling point, with as little as 5-sec lag in sampling line.—*Leeds & Northrup Co.*, 4901 *Stenton Ave., Philadelphia* 44, *Pa.*

For more information circle **204** on inquiry card.

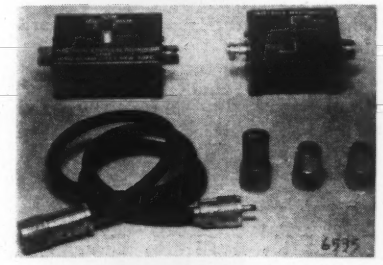


(it can be done in less than 5 seconds without tools or recordable temperature variation).—*West Instrument Corp.*, 4363 *W. Montrose Ave., Chicago, Ill.*

For more information circle **205** on inquiry card.

FAST PULSE TRANSMISSION EQUIPMENT

New line comprises most equipment needed for wide-band pulse transmission problems from dc to 1 millimicro-

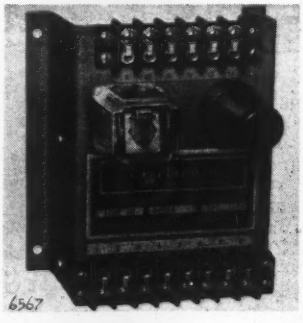


second risetime pulses (0 to 350 Mc). Standard coaxial cables prefabricated to any desired length with any desired standard connectors, coaxial line terminations for any impedance from 50 to 200 ohms, impedance matching boxes for joining different impedance lines, pulse splitters-mixers, pulse attenuators, and variable pulse delay boxes included.—*Electrical and Physical Instrument Corp.*, 42-19-27*th St., Long Island City* 1, *N. Y.*

For more information circle **206** on inquiry card.

LIQUID-LEVEL CONTROLLER

New "MEK-3001A Electronic Liquid Level Control" minimizes maintenance in industries that cannot af-



FOUND- the MISSING LINK in electronic control... the electro-hydraulic FINAL CONTROL element

NEW ASKANIA
ELECTRO-HYDRAULIC VALVE ACTUATOR IS CONTINUOUS-ACTING, DEPENDABLE

• Here's a new valve actuator which makes remote *electrical operation of the final control element* a reality for the first time. Adaptable to practically all electronic controllers, it produces an accurate, dependable heavy duty action capable of delivering a 600 lb. thrust to slide stem valves up to 8 inch size. Relays and positioners are eliminated because the actuator connects directly to the controller.

SIMPLE OPERATION... EASY MAINTENANCE

• Operation of the Askania **"EHVA"** is automatic. Maintenance is less because there are no compressors, dehumidifiers, filters or piping to create trouble.

Trouble sources are greatly minimized... failures seldom encountered...easy to locate and rectify.

ELIMINATES WEATHER FACTOR

• Electrical operation means no inconvenience or failure from condensation or freezing. Trouble free operation under any conditions... indoors or out, winter or summer...is assured—*all the way to the final control element* with Askania's Electro-Hydraulic Valve Actuator.

Check These Facts: Permits all Electric Control Throughout the System • Weatherproof Performance • Simple to Install—and Operate • Continuously responsive to small signal changes • Accurate Valve Positioning Assured by Force Balance Principle.

FEATURES:

Valve Stem Speed...0.5 in/sec	Valve Stem Thrust...600 lbs.
Valve Stem Stroke	½ to 2 inches
Input Coil Resistance	3,000-18,000 ohms
Input Signal	approx. 75 milliwatts d.c.

Write **for Bulletin No. 200 for complete information on how "EHVA" control might be adapted to your control system.**

CONTROLS FOR INDUSTRY

ASKANIA REGULATOR COMPANY

268 East Ontario Street, Chicago, Illinois

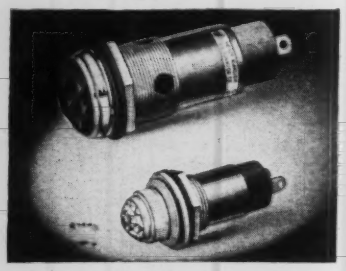
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A Subsidiary of General Precision Equipment Corporation

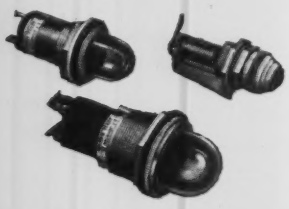
For more information circle **68** on inquiry card.

NOW!
QUICK-EASY SELECTION

Johnson
PILOT LIGHTS



For "in the field" replacement or original equipment manufacture, you'll find that it's easier and faster to specify Johnson Panel Indicators. Available in a wide variety of types, Johnson "preferred" units are immediately available at parts distributors throughout the country. Careful standardization, with an eye to replacement as well as interchangeability, makes Johnson Pilot Lights the first choice of many leading manufacturers.



Available types include: continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass and lucite jewels in clear, red, green, amber, blue, or opal lenses. Specials, including those meeting military specifications are also available in production quantities. For full information write today!

NEW CATALOG! Covers complete Pilot Light Line—write for your copy today!

SOLDERLESS NYLON CONNECTORS

Available in 11 bright colors. Shockproof nylon sleeves won't chip or crack with hardest usage. Excellent for high voltage applications. Highly resistant to extremes of heat, cold, and moisture. Tip and banana plugs designed for simplified solderless connection of up to 16 gauge stranded wire — jacks require soldered connection. Simple, functional design gives top quality at low cost.

Write for samples, prices, and further information.

E. F. Johnson Company
2714 SECOND AVE. S.W. • WASECA, MINN.

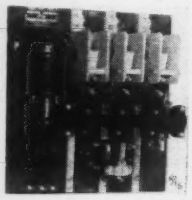
For more information circle **69** on inquiry card.

NEW INSTRUMENTS

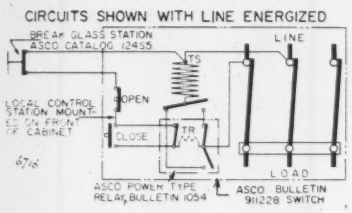
ford down-time. Among features: plug-in relay encased in a transparent cover permitting inspection of circuit operation as well as preventing entry of dust, etc. Controller is applicable to any liquid whose resistivity is between 0 and 2,000,000 ohms/cm³. Shock hazard is eliminated since probe voltage is less than 12.5 v and is isolated from ac power.—*Machinery Electrification, Inc., Northboro, Mass.*

For more information circle **207** on inquiry card.

OIL BURNER SAFETY REMOTE CONTROL



New "ASCO Remote Control Switch" for oil burner panels, designed to N. Y. City Board of Education specs, disconnects power supply from oil burner circuits automatically, upon operation of a break-glass type station through a relay holding circuit. Resetting switch must be made from control station located at panel. Resetting is impossible unless break-glass station switch contact is closed (i.e., broken glass has been replaced).—*Automatic Switch Co.*, 391 *Lakeside Ave., Orange, N. J.*



For more information circle **208** on inquiry card.

SAFETY SYSTEM FOR LIQUID FUEL HANDLING

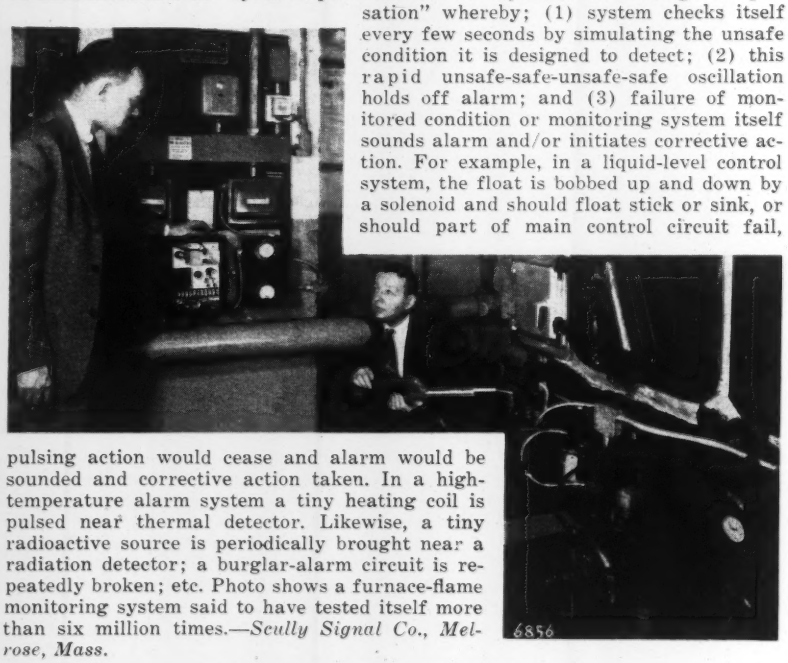
New "MG-5 Automatic Process Control" safeguards handling of liquid fuels and flammable liquids;

checks adequacy of all grounds and/or bonding connections and, if unsatisfactory, automatically prevents all loading or transfer operations. Photo shows typical bulk station - truck transport loading set-up.—*The Hewson Co., Inc.*, 443 *Broad St., Newark 2, N. J.*

For more information circle **209** on inquiry card.

SAFETY SYSTEM FOR CONTROLLERS, ALARMS, ETC.

New "Scully-Rowell Fail-Safe System" utilizes a unique method, referred to in announcements as "dynamic perturbation" or "dynamic monitoring" or "pulsation" whereby; (1) system checks itself every few seconds by simulating the unsafe condition it is designed to detect; (2) this rapid unsafe-safe-unsafe-safe oscillation holds off alarm; and (3) failure of monitored condition or monitoring system itself sounds alarm and/or initiates corrective action. For example, in a liquid-level control system, the float is bobbed up and down by a solenoid and should float stick or sink, or should part of main control circuit fail,



pulsing action would cease and alarm would be sounded and corrective action taken. In a high-temperature alarm system a tiny heating coil is pulsed near thermal detector. Likewise, a tiny radioactive source is periodically brought near a radiation detector; a burglar-alarm circuit is repeatedly broken; etc. Photo shows a furnace-flame monitoring system said to have tested itself more than six million times.—*Scully Signal Co., Melrose, Mass.*

For more information circle **210** on inquiry card.

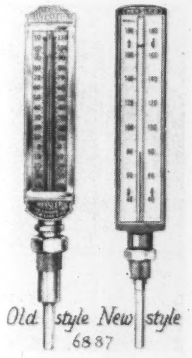
SAFETY CONTROL FOR DIELECTRIC HEATERS

New "AS3W Automatic Arc Suppressor," designed specially to make electronic wood gluing a safer operation, is a small electronic accessory which detects an arc almost before it begins. It shuts down the generator immediately, before any damage is done. It can be added onto any electronic generator "at nominal cost."—*Thermatron Div., Radio Receptor Co., 251 West 19th St., New York 11, N. Y.*

For more information circle **211** on inquiry card.

TEMPERATURE

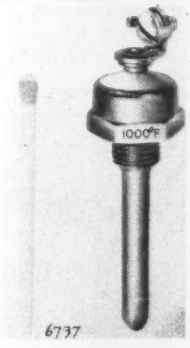
INDUSTRIAL THERMOMETERS



Newly redesigned industrial and mercury-in-glass thermometers feature one-piece streamlined cast-aluminum case with hard baked enamel finish. Use of aluminum saves cost and weight; enamel finish permits retention of bronze appearance. Available in 7", 9" and 12" sizes in all standard angles, in a variety of ranges from −100°F to 950°F. Stem connection permits interchangeability of all SPT sizes for UC and separable-socket assemblies.—*Weksler Thermometer Corp., 195 E. Merrick Rd., Freeport, L. I., N. Y.*

For more information circle **212** on inquiry card.

THERMAL SWITCH



New thermal switch weighs less than 1 oz; features an operating differential of plus or minus 1°F; "extremely fast response"; temperature ranges from minus 20°F to 1,000°F; will continue to operate accurately even when subjected to momentary overshoots to 2,000°F; also on undershoots to −80°F. Rating 1½ amp at 28 vdc resistive.—*Control Products, Inc., 306 Sussex St., Harrison, N. J.*

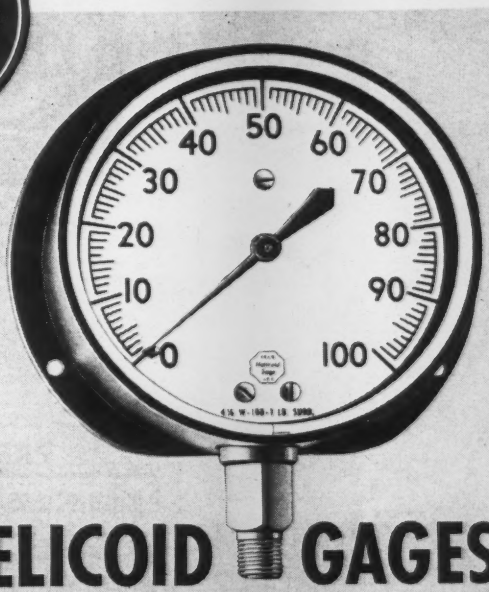
For more information circle **213** on inquiry card.

SURFACE THERMOMETER

New "Model 573," said to be "made entirely of stainless steel," has a range of 50°F to 1060°F. Diameter

an ACCO product

Helicoid Gages



How HELICOID GAGES can save YOU money!

LONG LIFE:

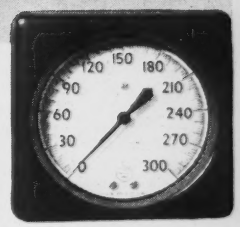
HELICOID Gages are pressure instruments of extreme precision and long, trouble-free service with minimum maintenance. Have no gear teeth to wear out.

SUSTAINED ACCURACY:

HELICOID Gages have many unique and exclusive features which result in the highest degree of gage accuracy. Tubes, for instance, will withstand hundreds of thousands of pressure pulsations and will not stretch, leak or crack.

JOB-DESIGNED:

HELICOID Bourdon tubes are made from seamless tubing of alloy steel, K Monel, stainless steel or phosphor bronze. Each is designed to give best service under specific conditions. Available in complete line of cases for wall or stem mounting.



Acaloy square flush case

Helicoid Chemical gage

Send for catalog

ACCO

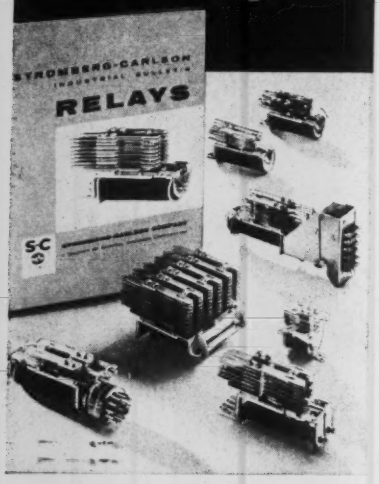
Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-B Connecticut Avenue • Bridgeport 2, Connecticut

for Better Value

For more information circle **70** on inquiry card.

TWIN CONTACT
Relays



No more "priority"!

Expanded production enables us to offer our Telephone type twin-contact Relays to any industry.

For many years, Stromberg-Carlson production of twin-contact Telephone type relays has been completely absorbed by the independent telephone industry.

Last year, we became a division of General Dynamics Corporation. A five-million-dollar expansion program is under way and one result is already increased relay manufacturing facilities, enabling us to broaden our distribution.

These relays—proven by years of reliable service in the telephone field—are designed to operate under extreme ranges of temperature and humidity. They are made in many types of which these are typical.

Type A is a general-purpose relay especially adapted to the control of switching operations.

Type B is a gang-type relay which can be equipped with three times the number of spring combinations as the "A" type.

Type C. Two relays on the same frame; mounts in same space as the "A" type. It is particularly effective where small space is a factor.

Type D. Miniature general-purpose relay of approximately ⅓ the size of "A".

The catalog in the photograph above gives fuller specifications. We'll gladly send one on request.

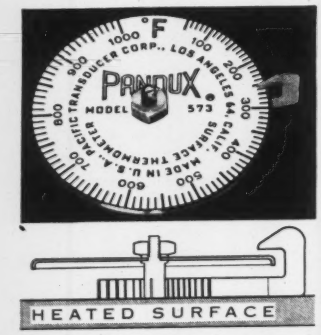
S-C STROMBERG-CARLSON

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION • TELEPHONE INDUSTRIAL DEPT., 113 CARLSON ROAD, ROCHESTER 3, N. Y.

For more information circle **71** on inquiry card.

NEW INSTRUMENTS



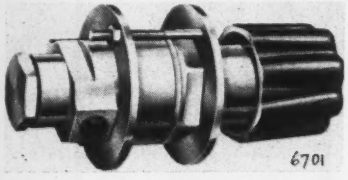
1¾"; weight ⅓ oz.—*Pacific Transducer Corp.*, 11836 *W. Pico Blvd., Los Angeles* 64, *Calif.*

For more information circle **214** on inquiry card.

PRESSURE

HIGH-PRESSURE REGULATOR

New high-pressure regulator is said to offer "the widest adjustment range available." Among other features:

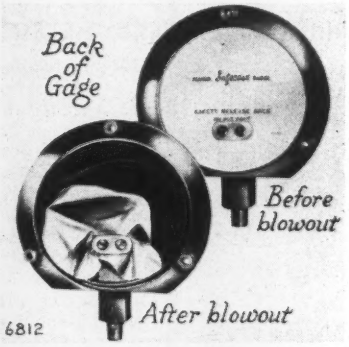


¼" tube straight-thread gasket-seal bosses per AND10050; maximum inlet pressure 4500 psi; internal relief valve and 5-micron filter removable without disturbing spring and diaphragm structure; mounting brackets continuously adjustable through 360°; low-rate springs maximize flow sensitivity; internal stops protect intervalve structure; also protection from line failures and misapplication of pressures.—*Accessory Products Corp.*, 616 *W. Whittier Blvd., Whittier, Calif.*

For more information circle **215** on inquiry card.

SAFETY-CASE GAGE

New "Safecase" pressure gage provides maximal safety on dangerous installations. Solid front protects gage face and relatively thin stainless plate, covering back of case, relieves all explosive pressures. Back plate is held firmly to case and will not become detached in event of a blow-out. —*Jas. P. Marsh Corp.*, 3501 *West Howard St., Skokie, Illinois.*

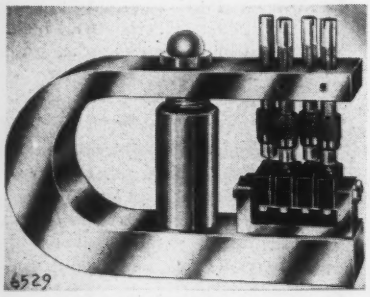


For more information circle **216** on inquiry card.

FORCE, ACCELERATION, VIBRATION

MULTI-POINT LOAD SWITCH

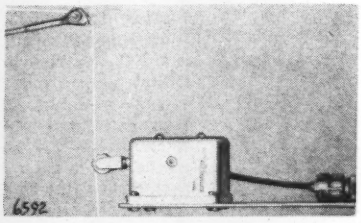
New "Multi-Switch Force Gauge" is available in 11 different capacities from 0-10 lb to 0-50,000 lb, with one to four switches. Force-measuring "U" is designed to flex millions of cycles without losing its resiliency. Each switch can be set to function at a different load point, or all switches can be made to function at same load. Adjustment screws sealed at factory, or adjustable models.—*W. C. Dillon & Co., Inc., P. O. Box* 3008, *Van Nuys, Calif.*



For more information circle **217** on inquiry card.

PRECISION DYNAMOMETER

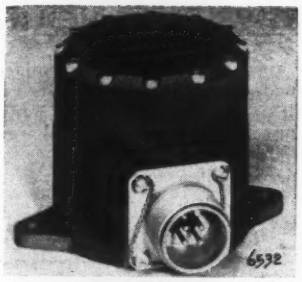
New "Type TDC-3" beam-type dynamometer provides a highly accurate and sensitive means of measuring forces in any direction; incorporates outstanding features of maker's linear variable differential transformer; is available in ranges from 0-10 grams to 0-50 pounds.—*Schaevitz Engineering, P. O. Box* 505, *Camden* 1, *N. J.*



For more information circle **218** on inquiry card.

ACCELERATION PICKUPS

New "GG22" pickups, designed for missile and aircraft applications, sense positive or negative accelera-

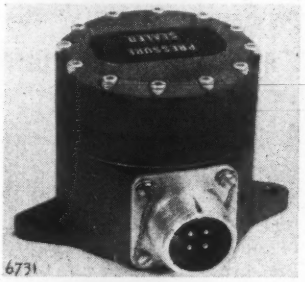


tions, or both, in either vertical or horizontal planes. Models are available in ranges from less than ±0.5 *G* full scale to more than 50 *G*. Linearities as low as ±0.5% and threshold as low as 0.009 *G.—Doelcam Div., Minneapolis-Honeywell,* 1400 *Soldiers Field Road, Boston* 35, *Mass.*

For more information circle **219** on inquiry card.

ACCELERATION PICKUP

New "Model R-1430," though ultrasensitive, offers the same rugged construction as that of 50-*G* models for

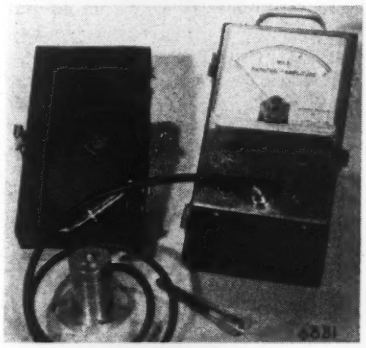


missiles and aircraft. Range ±0.1*G*; threshold 0.002 *G* max (0.1° from vertical); operating temperature to 325°F.—*Dept. A, Cedar Engineering, Inc.,* 5806 *W.* 36*th St., Minneapolis* 16, *Minn.*

For more information circle **220** on inquiry card.

VIBRATION INDICATOR

New transistorized vibration indicator has no interstage capacitors or transformers to limit frequency re-



sponse; uses low-voltage batteries; has ranges of either 0.03" or 0.003" with graduations readable to 0.0001". Pickup is magnetic velocity type and network integrates velocity signal to

ONLY ONE REGULATOR PROVIDES PNEUMATIC CONTROL LIKE THIS!

Governaire

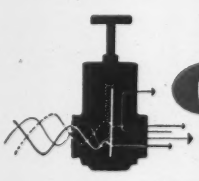
ZERO | ZONE

PRECISION PRESSURE REGULATORS

"Governaire" is the name of an entirely new design and achievement in precision controls for pneumatic loading. They differ from ordinary, existing instruments in their superior accuracy, greater reliability, improved immunity to variations in supply pressure and ability to fill or exhaust a remote volume far more rapidly. Typical flow curve shown above (Series 4000) graphically illustrates Governaire's minimum pressure offset effect as *Zero-Zone* is passed.

Typical specifications of the Series 4000 Regulator include five ranges (10, 30, 60, 150 and 250 psi); high capacity ⅝" diameter supply and exhaust seats (no other regulator of equal pipe size has even a *supply* capacity equal to the Series 4000 *exhaust* capacity); three sizes (⅜", ½" and ¾" NPT with two ¼" gauge taps). The Series is especially suited to such machine applications as welding head pressure control, punch press brake and clutch control, cable and sheet tensioning devices, etc.

Series 4000 is one of eight Governaire precision control devices now in production and available for delivery. Descriptive information and performance data on any will be sent on request. Write, outlining your application.



Governaire

DIVISION OF BELLOFRAM CORPORATION
BURLINGTON, MASSACHUSETTS

For more information circle **72** on inquiry card.

Controlling a TV tower elevator

without dangling wires

AN ELEVATOR in a television tower is quite unique . . . and it's an innovation to be able to control the elevator without wired connections between the cab and the drive motor controller. The usual two-wire elevator control circuit has been eliminated in the new UNION "TVL," Inductive Elevator Control. In its place, control is accomplished by means of low-frequency carrier wave on a single carrier cable permanently anchored to the tower structure. This fail-safe system eliminates such problems as dangling control cable being blown by high winds out of the tower framework and cam-stop controls becoming inoperative from frozen ice accumulation.

The operator can stop the elevator at any level by simply pushing a button. Limit switches stop the car automatically when it arrives at either terminal.

In addition, the UNION "TVL" system contains a noise-free communication channel that assures constant voice contact between car and tower base.

What is your control problem?

Union Switch & Signal engineers have solved many complex industrial control problems such as control of steel mill soaking pit doors from a traveling crane, centralized control of pipelines, aircraft flight simulators, control of ground handling equipment for guided missiles and many other "tools for automation." Remote control is our specialty. Write us about your problem. Our engineers can probably help you work out a satisfactory solution.

GENERAL APPARATUS SALES

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

Pittsburgh 18 Pennsylvania

For more information circle **73** on inquiry card.

NEW INSTRUMENTS

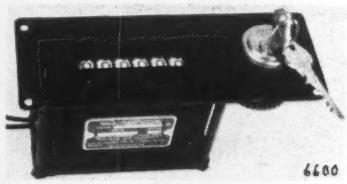
give amplitude. Instrument weighs 3 lbs and complete equipment 5 lbs.—*Vibration & Engineering Balancing Service, 411—15th St., Virginia Beach, Va.*

For more information circle **221** on inquiry card.

COUNTING

KEY-LOCK RESET COUNTER

New key-lock-reset magnetic counter has a sturdy tumbler lock. One

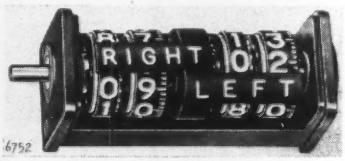


turn of key resets all 6 figures to zeros.—*Veeder-Root Inc., Hartford 2, Conn.*

For more information circle **222** on inquiry card.

ADD AND SUBTRACT COUNTER

New "Model 2-2-Y-8707-B" high-speed dual-bank add and subtract counter, for a navigating instrument,

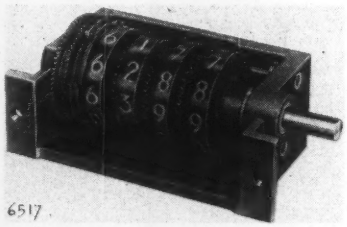


has shutter to block off one side of counter when it passes through "0" point. Shaft speed 1200 rpm: 120,000 increments per minute on unit wheel.—*Durant Mfg. Co., 1981 N. Buffum St., Milwaukee 1, Wis.*

For more information circle **223** on inquiry card.

MIL COUNTER

New 4-drum "Model 1864," for angular indications in mils instead of degrees, provides 10 counts on its unit



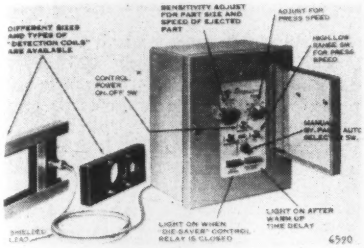
drum for each rev. of input shaft. Counting from 0 to 6399 mils with return to 0, it is reversible at any point in its complete cycle. It can also be furnished with maximum indications of 3199 mils. It will withstand 50-hr salt-spray tests.—*Bowmar Instrument Corp., 2415 Pennsylvania St., Fort Wayne, Indiana.*

For more infomation circle **224** on inquiry card.

SHOP EQUIPMENT

AUTOMATIC CONTROLLER FOR STAMPING PRESSES

New "Die-Saver" is an electronic control which attaches easily to stamping presses to reduce or elimi-

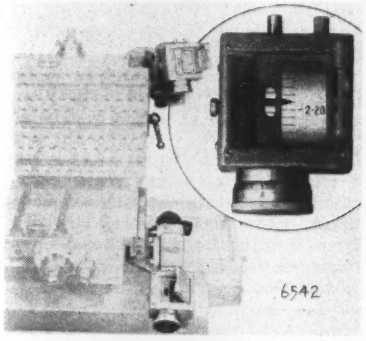

DIFFERENT SIZES AND TYPES OF "DETECTION COILS" ARE AVAILABLE
SENSITIVITY ADJUST FOR PART SIZE AND SPEED OF EJECTED PART
ADJUST FOR PRESS SPEED
HIGH-LOW RANGE SW. FOR PRESS SPEED
CONTROL POWER ON-OFF SW.
SHIELDED LEAD
LIGHT ON WHEN "DIE-SAVER" CONTROL RELAY IS CLOSED
LIGHT ON AFTER WARM-UP TIME DELAY
6590

nate possibility of damage to dies and presses due to "double heading" on non-ejected parts.—*Robotron Corp., 21362 W. 8 Mile Rd., Detroit 19, Mich.*

For more information circle **225** on inquiry card.

MACHINE-TOOL SCALES

New Hilger & Watts (British-made) machine tool scales and projectors, direct reading to 0.0001", on

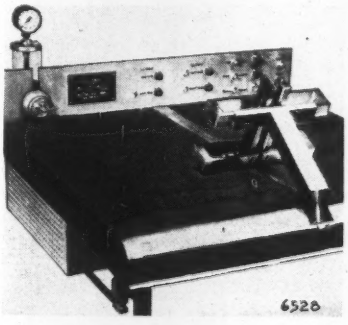


"Ex-Cell-O" precision boring machine, show horizontal motion of 9" and vertical motion of 4" clearly on two conveniently located projection screens.—*Engis Equipment Co., 431 So. Dearborn St., Chicago 5, Ill.*

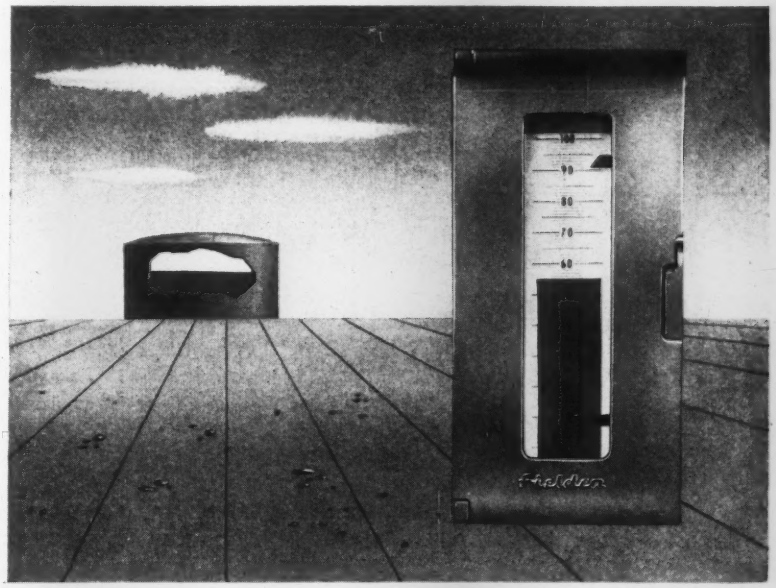
For more information circle **226** on inquiry card.

LEAD CUTTER-FORMER

New "Lead Former" provides completely automatic cutting and forming of coaxial leads (pigtails) of components; is available in three models

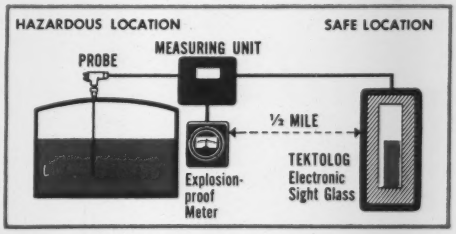


Now See Level "Inside" Vessels from Panels ½ Mile Away



With a new Fielden unit, the level of any liquid, powder, interface, or granular solid can be measured accurately in any area . . . and reproduced visually as far as ½ mile away.

This equipment now enables you to combine all the advantages of capacitance level measurement with the convenience of 8½" vertical scale indication and control. Level is measured and indicated locally and/or remotely by a Fielden Series 10 TELSTOR, Series 42 Null Balance or Series 16 Continuous Level Telemetering System. A TEKTOLOG Electronic Sight Glass of panel space-saving design then shows level graphically by means of a moving colored tape.



Features

- TEKTOLOG Electronic Sight Glass available for electric control with up to 4 separate points
- Indicates level of any material—conducting or non-conducting
- Measures entire spans or any portion—up to 150 or 200 feet.

Robertshaw-Fulton CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
Dept. A, 2920 N. 4th St., Philadelphia 33, Pa.

Please send me bulletins on the following systems using Fielden TEKTOLOG Electronic Sight Glass

- ☐ TELSTOR Continuous Level System
- ☐ Series 16 Continuous Level Telemetering System
- ☐ PNEUTRONIC Level Control
- ☐ TEKTOR Level Limit Control
- ☐ Series 42 Null-Balance Continuous Level System

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

For more information circle **74** on inquiry card.

New Genisco Accelerometer

for airborne flight and fire control

The new Model GLO Accelerometer is "tailor made" for use in today's high speed aircraft where acceleration measurement is required for precise guidance and control.

Adapted from the very successful Genisco Model GLH Accelerometer, the Model GLO is enclosed in a new aircraft-type case filled with oil to damp vibration of the parts. The instrument operates to specifications requiring the most severe vibrational environments.

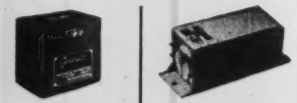
Delivery schedules are especially good, since many parts are interchangeable with other accelerometers now in high-quantity production.

GLO SPECIFICATIONS

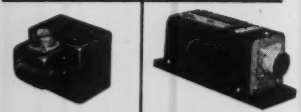
RANGE: ±0.1 g to ±5 g's, or up to 30 g's with reduced damping.
DAMPING: 0.5 to 0.8 critical.
VIBRATION: MIL E5272A, PROC. I.
STEADY STATE: 30 g's on all axes.
SHOCK: MIL E5272A, PROC. I.
TEMPERATURE RANGE: −65° F. to +180° F.
SIZE: 3¼" D. by 3⅞".
WEIGHT: 2¾ lbs.

Dual potentiometers and caging available.

Other Standard Genisco Accelerometers



Model GLH | Model GMO



Model GOH | Model GMH

Write for data.

Genisco INCORPORATED

2233 Federal Ave., Los Angeles 64, California

Reliability first

For more information circle **75** on inquiry card.

NEW INSTRUMENTS

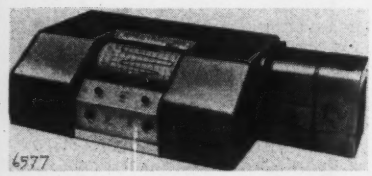
of two, four or six slides depending on final lead shape desired. It speeds production and effects "a substantial improvement in quality of the finished product." It is pneumatically operated and electrically controlled.—*Design Tool Corp., 80 Washington St., New York, N. Y.*

For more information circle **227** on inquiry card.

LABORATORY EQUIPMENT

UV SPECTROGRAPH

New double monochromator for qualitative and quantitative analysis is available for "Spectarcord" high-



speed fully automatic ultraviolet instrument, providing high-resolution continuous spectra on a sample within 90 seconds. Complex analyses require no more than 12 minutes. Instrument records in linear transmittance or, optionally, in linear absorbance. An available attachment extends range through the visible and into near infrared field.—*The Perkin-Elmer Corp., Norwalk, Conn.*

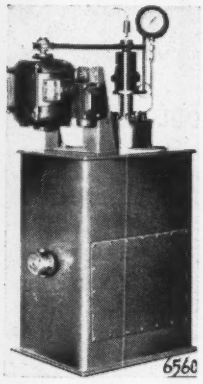
For more information circle **228** on inquiry card.

PARTICLE ACCELERATOR

New 3-million-volt Van de Graaff particle accelerator, said to be "the most powerful and versatile machine radiation source now commercially available," produces nearly all the fundamental radiations: electrons, x-rays, positive ions or neutrons. Conversion from production of one type of radiation to another is a relatively simple step. Unit weighs 9 tons; is designed for vertical or horizontal mounting for a wide range of processing, radiographic, medical and research programs.—*High Voltage Engineering Corp., 7 University Road, Cambridge 38, Mass.*

For more information circle **229** on inquiry card.

AUTOCLAVE

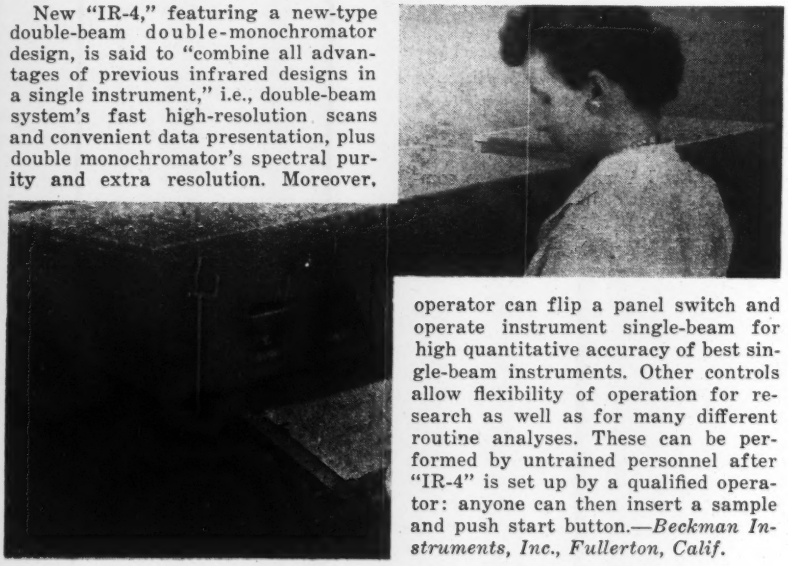


New high-pressure autoclave features water-cooled drive shaft that lengthens life of packing seal around stirring drive shaft. Agitator is designed for all types of catalytic material from gases to solids. Safety feature is completely enclosed base which permits air purging as a guard against explosive vapors contacting heating elements. Pressures to 30,000 psi and capacities from 1 liter to 20 gallons.—*High Pressure Equipment Co., Inc., 1222 Lindon St., Erie, Pa.*

For more information circle **230** on inquiry card.

AUTOMATIC INFRARED SPECTROPHOTOMETER

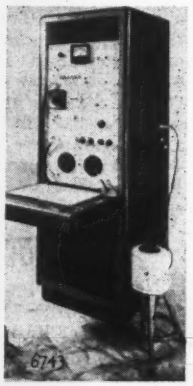
New "IR-4," featuring a new-type double-beam double-monochromator design, is said to "combine all advantages of previous infrared designs in a single instrument," i.e., double-beam system's fast high-resolution scans and convenient data presentation, plus double monochromator's spectral purity and extra resolution. Moreover,



operator can flip a panel switch and operate instrument single-beam for high quantitative accuracy of best single-beam instruments. Other controls allow flexibility of operation for research as well as for many different routine analyses. These can be performed by untrained personnel after "IR-4" is set up by a qualified operator: anyone can then insert a sample and push start button.—*Beckman Instruments, Inc., Fullerton, Calif.*

For more information circle **231** on inquiry card.

GAMMA-RAY SPECTROMETER

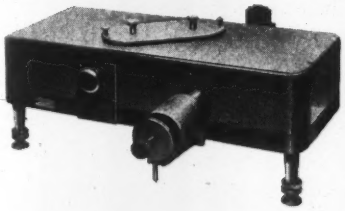


New "DX-41 Gamma Ray Spectrometer" comprises a well-type scintillation detector and 2" lead shield, a linear amplifier and a single-channel analyzer; also a preset time binary scaler and regulated 500-2,000-volt power supply. A linear counting rate meter and a strip-chart recorder are available—*Detectolab, Inc.*, 6544 *N. Sheridan Rd., Chicago* 26, *Ill.*

For more information circle **232** on inquiry card.

MIRROR MONOCHROMATORS

New Leiss (West Zone of Berlin) mirror monochromators combine a high amount of delivered energy with

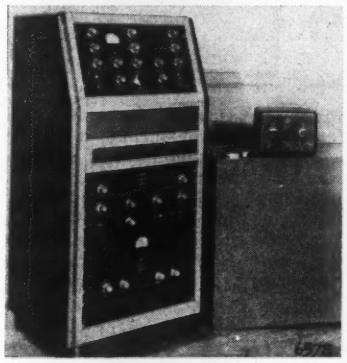


high spectral purity of light output. Among other advantages of mirror optics over lens optics: universal applicability over spectral range from ultraviolet to infrared; high dispersion; simple and precise adjustment. Available as single and double monochromators (latter illustrated).—*Photovolt Corp.*, 95 *Madison Ave., New York* 16, *N. Y.*

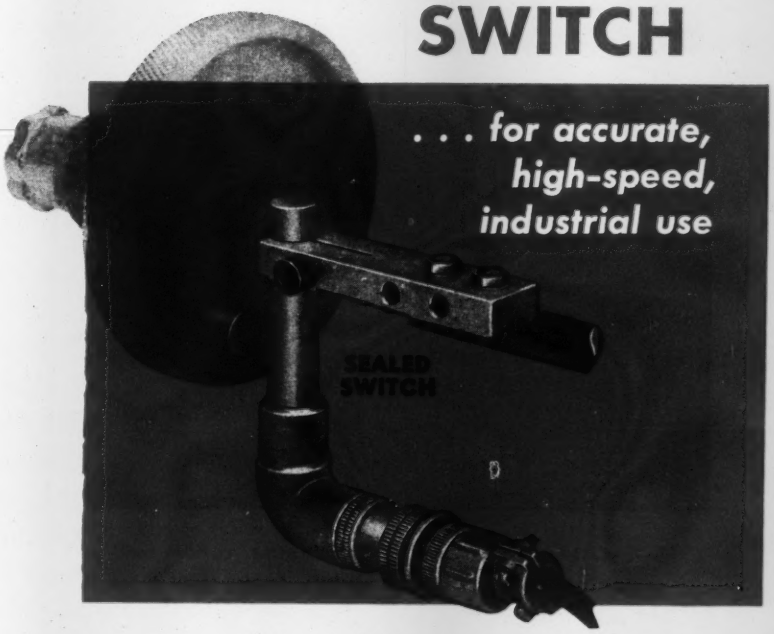
For more information circle **233** on inquiry card.

MAGNETIC-FIELD CONTROLLER

New "Model C-1 Numar* Magnetic Field Control System" permits highly accurate stabilization and control of magnetic fields in range of 300 to 18,750 gauss. Utilizing principles of nuclear magnetic resonance, it controls magnetic fields by deriving error



POST Decitron MAGNETIC SWITCH



Positive 'sensing' from zero to 100 cycles per second

The Post model MH-2 is a magnetically operated high-speed switch which is controlled by the proximity of a magnetic field. When the magnet reaches the face of the sealed switch, there is a clean 'make', or contact, and as the magnet moves away, a positive 'break' occurs. No lag . . . no jumping.

Unique in operation, the MH-2 works fully as well at low speeds. For example, a clearly defined 'make' and 'break' is possible at any speed range from zero up to 100 cycles per second. The MH-2 has a 'life' of over 30 billion cycles.

Post's MH-2 is an ideal sensing device for actuating electronic and mechanical counters, controls, solenoids, relays, and other electrical and electronic circuits. Write Post for descriptive literature "M" today.

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POST

Electronic Products Division

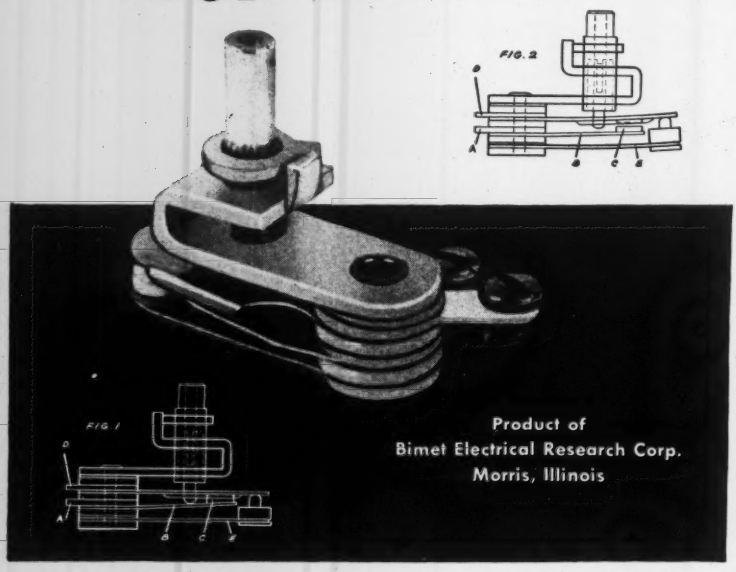
POST MACHINERY CO.

Elliott Street—Dept. M Beverly, Massachusetts

For more information circle **76** on inquiry card.

How Chace Thermostatic Bimetal actuates the

Belcor Thermostat



Belcor Thermostats are precision-made, custom-built at costs comparable with stock thermostats. Features of these thermostats include: elimination of false cycling and "chatter" of contact points by virtue of passing current through the independent contact springs rather than the bimetal member; although pre-calibrated, a trim screw inside the adjusting shaft simplifies re-adjustment or re-calibration; single stud mounting gives fast transfer of heat and a single through-hole facilitates assembly.

Operating temperatures available up to 600 degrees F. UL approved, these thermostats include open and fully closed types. Contact ratings afford a variance to a maximum of 1500 watts at 120-240 V. AC.

How it works: In the normally closed circuit position (Fig. 1), current passes from terminal (A) through stainless steel spring (B) and silver contacts (C) back to terminal (D). Ambient temperatures in excess of the factory calibrated rating cause the Chace Thermostatic Bimetal strip (E) to deflect (Fig. 2), opening the circuit at contacts (C) until temperature is again normalized.

Chace Thermostatic Bimetal is available in 29 types, in strip, coil or in complete elements made to customer specification. Write now for our free 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal."

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1609 BEARD AVE., DETROIT 9, MICH.

For more information circle **77** on inquiry card.

NEW INSTRUMENTS

signals directly from the field, rather than from magnetizing coil voltage or current measurements. It can be used to control magnetic analyzing field of a particle accelerator; to control magnets of microwave spectrometers and mass spectrometers, etc. —*Nuclear Magnetics Corp. Div., The Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **234** on inquiry card.

TWO-UNIT BATH

New "Two-Unit Gum Bath," developed primarily for determinations of gum content of aviation and motor gasolines by the air jet method, is suitable

for gum determinations of all aromatic and aliphatic petroleum distillate products in distillation range below that of kerosene. Central distribution system distributes equal volumes of air through two preheating coils immersed in bath and then onto surfaces of both samples.—*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

For more information circle **235** on inquiry card.

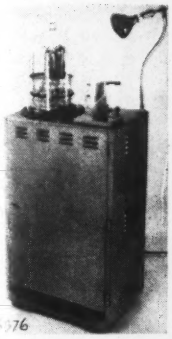
DIELECTRIC OVEN

New radiofrequency laboratory oven, for instantaneous drying of sample quantities of various solid and

liquid materials, generates 2 kw (rated) hf power output; is fully automatic; has unique electronic load matching system which automatically compensates for variations in physical properties of heated material during heating cycle, assuring constant power input into sample. Power level can be adjusted from zero to full rated power.—*ERDCO Engineering Corp., Addison, Ill.*

For more information circle **236** on inquiry card.

FREEZE-DRYER

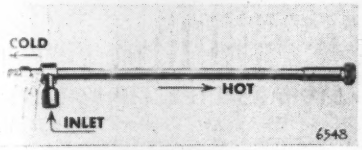


New mobile freeze-drying unit is said to perform many functions never before found in a single freeze-drying apparatus. It comprises a Pyrex drying chamber, interchangeable tray-support, glass trap with capacity of 1200 ml of effluent, secondary stainless steel trap with inner condenser, Welch "Duo Seal" vacuum pump, McLeod gage, variable-intensity infrared unit, guard for Pyrex drying chamber and cabinet on casters.—*Palo Laboratory Supplies, Inc.*, 81 *Reade St., New York 7, N. Y.*

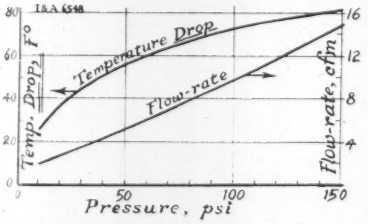
For more information circle **237** on inquiry card.

HILSCH VORTEX TUBE

New "Model SS-8" converts entering compressed air into a sort of spectrum of hot-to-cold molecules and



separates faster (hotter) and slower (colder) molecules, by utilizing Ranque-Hilsch Effect: air or gas is



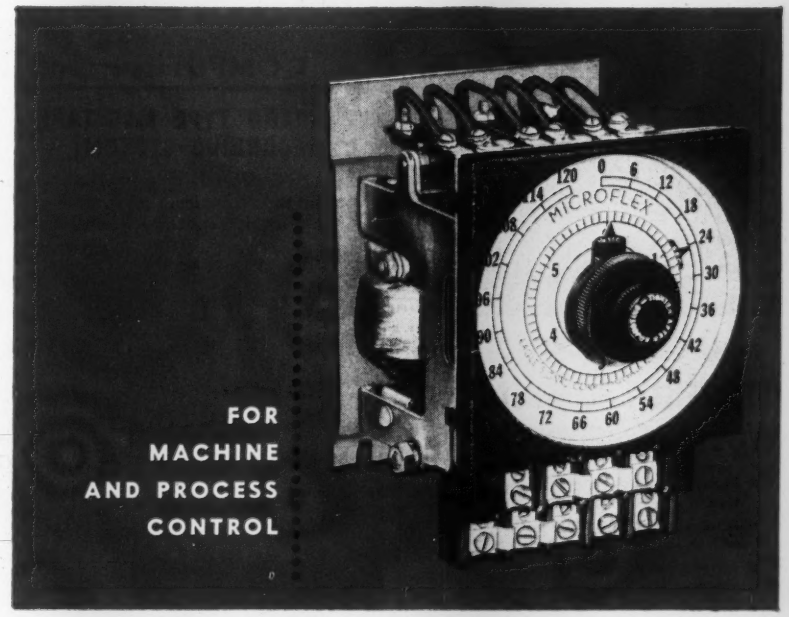
caused to enter tangentially into a precisely-shaped chamber where energy distribution allows autoseparation of heated (outer) and cooled (central) fractions. Efficiency is low —as compared to standard refrigeration systems—but device should find many industrial as well as lab uses by reason of its convenience and small size (17" long).—*Fisher Governor Co., Marshalltown, Iowa.*

For more information circle **238** on inquiry card.

ELECTRON DIFFRACTOGRAPH

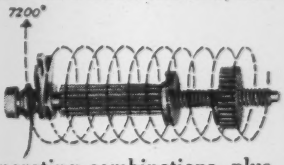
New Electron Diffractograph (made by Trub, Tauber & Co. AG) is a new type of instrument for structural research of materials, thin layers or surfaces. It can be used for direct observation of diffraction pattern on a fluorescent screen or for photographic recording. Beam diame-

EAGLE
Microflex Reset Timer



Insures "20-to-1 ratio" accuracy

Time settings of pinpoint accuracy are a reality, thanks to the Microflex double dial. It takes one complete turn of the *inner* dial to advance the *outer* dial just one division. That's a 20-to-1 ratio, made possible by the patented Microflex threaded axle and pinion (see sketch). Examples of resultant accuracies are ± 1/60 of a second on a 20-second dial, and ± 1/10 of a second on a 120-second dial.



The Microflex Reset Timer is driven by a heavy-duty industrial synchronous motor. Contacts are tripped closed or open after a preset time interval. Starting and resetting are electrically controlled. Microflex offers over 150 timer operating combinations, plus a wide range of long or short time periods. It's ideal for applications like molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

Write for free Automation Booklet and Bulletin 110.

MAIL COUPON TODAY

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. IA-456
MOLINE, ILLINOIS

Please send free Automation Booklet and Bulletin 110 containing complete data on Microflex Reset Timers.

NAME AND TITLE

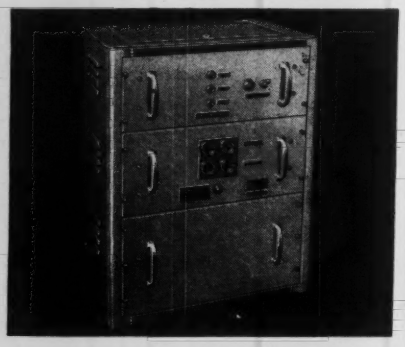
COMPANY

ADDRESS

CITY ZONE STATE

For more information circle **78** on inquiry card.

NOW... Noise Free A.C. Power!



NEW CURTISS-WRIGHT DISTORTION ELIMINATING VOLTAGE REGULATOR

- Reduces typical power line distortion to less than 0.3%
- Furnishes 1.4 KVA of distortion-free power
- Electronically regulates 115 V output to ±1%
- Recovery time less than 1/50 cycle
- Provides additional 4 KVA of ±1% electromechanically regulated power
- Electromechanical time constant only 0.6 seconds
- Electromechanical regulator, unlike usual magnetic voltage stabilizer, introduces no distortion or phase shift

Here at last is the ideal solution to the disturbing problem of harmonics and low frequency noise appearing in 115 V., 60 cps power sources. In one compact package, every laboratory can now obtain *both*

1) distortion-free, regulated power when needed, and simultaneously

2) a large supply of electromechanically regulated power for applications where normal line distortion is tolerable.

In addition to its general laboratory utility, this instrument is ideally suited for preventing instability and inaccuracy in a.c. computer system nulling operations. Many other applications. 230 V. model also available. Immediate delivery. $1,689 f.o.b. Carlstadt, N. J. Write for details.

Component & Instrument Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION · CARLSTADT N J

For more information circle **79** on inquiry card.

NEW INSTRUMENTS

ter is less than 10 microns. Observation chamber has three viewing ports and a 3" pivotable fluorescent screen. Instrument allows every method of electron diffraction: Debye-Scherrer, Kichuchi, convergent beam of large aperture, parallel beam, etc. Two electromagnetic lenses of variable focal length make it possible to focus (1) on fluorescent screen for powder diagrams, (2) on sample for small beam diffraction, (3) above sample for shadow microscopy, (4) image of sample at 50× and (5) magnification of reflections.—*Norden-Ketay Corp., 555 Broadway, New York 12, N. Y.*

For more information circle **239** on inquiry card.

COMPUTING and DATA PROCESSING

KEYBOARD TYPE MAG-TAPE RECORDING SYSTEM

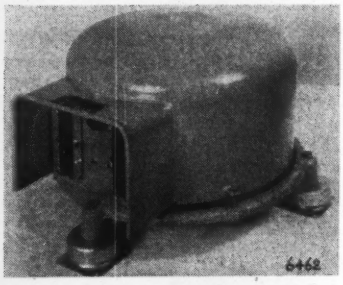
New "Codescriber" keyboard-to-magnetic-tape device, adaptable to any computer, contains arithmetic

circuits for address modification, visual indicators for decimal-digit-readout and register display. Automatic function buttons are provided for automatically inserting all repetitive data as well as subroutine call-up. Unit's magnetic tape recorder transcribes this information for use with computer input systems.—*Logistics Research Inc., Redondo Beach, Calif.*

For more information circle **240** on inquiry card.

STORAGE DRUM

New "Model ERA 1114" magnetic information storage drum has a capacity of 42,000 binary digits and a nominal speed of 3550 rpm. Features: non-contact recording and playback;

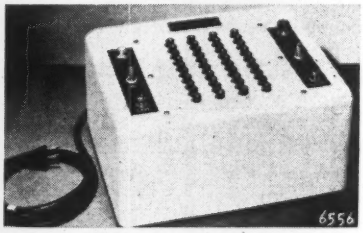


alterable yet non-volatile storage of information on over 20 information tracks by means of magnetized spots; random access; can withstand extreme environments.—*Remington Rand Univac Div., 1902 West Minnehaha Ave., St. Paul W4, Minn.*

For more information circle **241** on inquiry card.

KEYBOARD-TYPE CONVERTER

New "Keyboard Decimal-to-Binary Converter," said to be unique simplifies raw data conversion during si-



multaneous computing operations; converts a four-digit decimal number to 14 straight binary digits; obviates need for expensive programming systems. It inserts coefficients, constants

BALZERS Thin Film Optics

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Front Surface Mirrors, Cold Mirrors, Achromatic Beam Splitters, Dichroic Beam Splitters, Monochromatic Interference Filters, Wedge Interference Filters, Heat-Reflecting Interference Filters, Cut-Off Filters, Anti-Reflection Coatings, Heat Protective Coatings and many other thin layers.

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For more information circle **80** on inquiry card.

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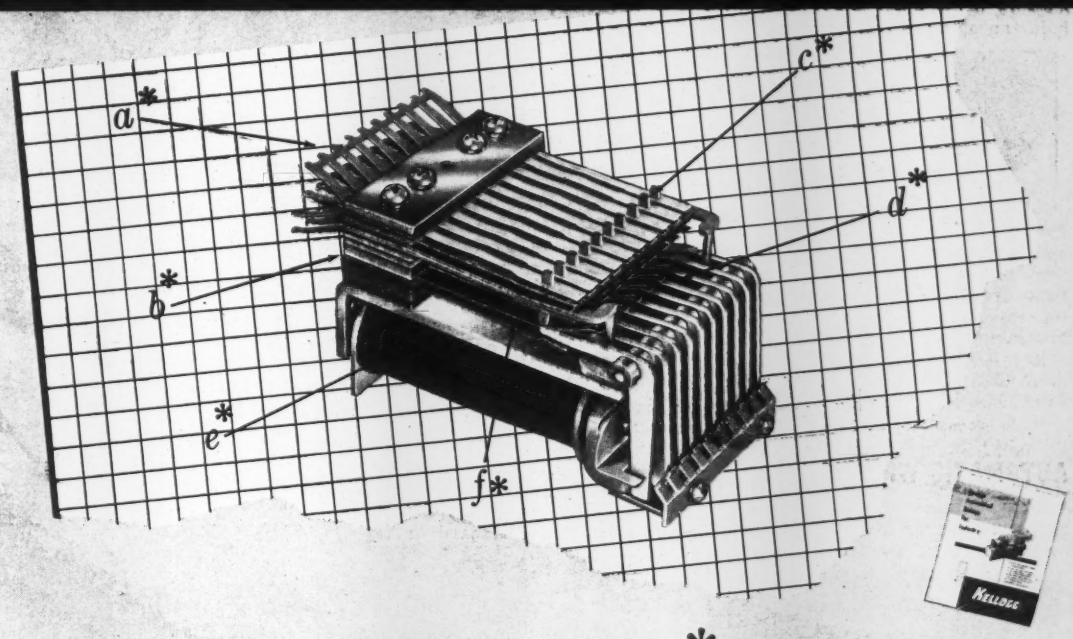

We have been making and improving relays for more than 58 years. The use of these relays in our own equipment has helped to make Kellogg the leader in the independent telephone field.

A typical example is this sequence relay, "the Kellogg Magnetic Impulse Counter." This unique counter eliminates sliding contacts, mechanical rachets, etc. . . . the counting sequence is controlled electromagnetically, with relay-type contacts used throughout. Production advantages include: simplified circuitry, reduced size, lower cost and longer life.

You can save design time and cut production costs because our intimate experience as a relay-user, as well as relay-maker, enables us to develop relays that are rated to meet your requirements . . . build them to stand up in your equipment, for a lifetime of service.

* *For the A.B.C.'s of the Magnetic Impulse Counter and other Kellogg relays use the attached card to send for this Kellogg Relay Bulletin.*

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For more information circle 81 on inquiry card.

and other data into a computer. Its output, in the form of relay closures, is fed through a multiconductor plug and output number is retained in event of power failure.—*Hanson-Gorrill-Brian, Inc.*, 85 *Hazel St., Glen Cove, N. Y.*

For more information circle **242** on inquiry card.

MAGNETIC HEAD

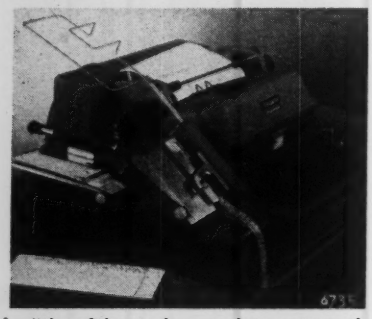
New single-track magnetic head for memory drum units is available with inductance values from 1 mh to 80mh.

Packing densities can be used to 100 per inch. Read-back voltages to 1.5 v peak to peak, depending on clearance from drum. Each coil can be utilized separately, in series or center tapped, providing complete flexibility of circuitry.—*Data Storage Devices Div., J. B. Rea Co., Inc.*, 1723 *Cloverfield Blvd., Santa Monica, Calif.*

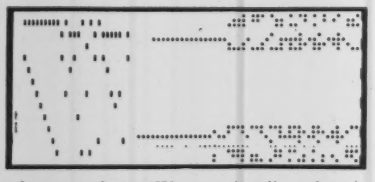
For more information circle **243** on inquiry card.

AUTOMATIC WRITING MACHINE

New "Flexowriter Duplex" automatic writing machine cable-connected to "Motorized Tape Reader" is said to



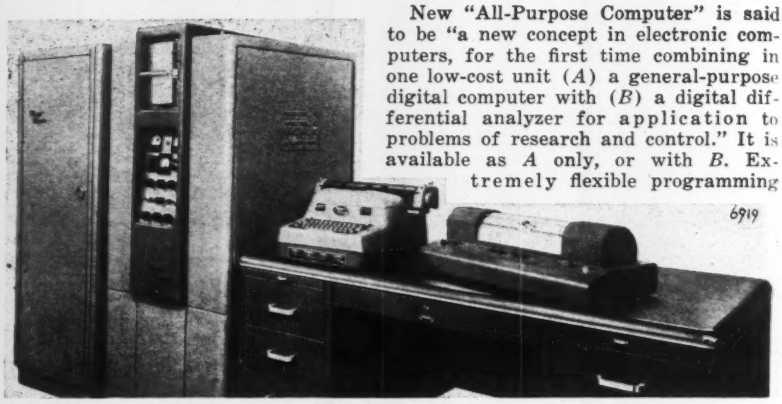
be "the ultimate in complete automatic typing." Operation is controlled entirely by punched paper tape to type personalized letters, invoices, orders and other documents automatically at 100 words per minute. Two punched paper tapes are used: one for date and body; the other for name and address, etc. ★New "Flexowriter Programatic" with "Edge-Card Punch and Reader"



edge-punches "Flexowriter" codes in IBM cards automatically during preparation of invoices, etc.—*Commercial Controls Corp.*, 1 *Leighton Ave., Rochester 2, N. Y.*

For more information circle **244** on inquiry card.

COMBINED DIGITAL COMPUTER AND ANALYZER

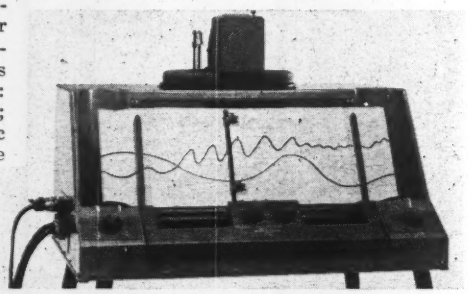


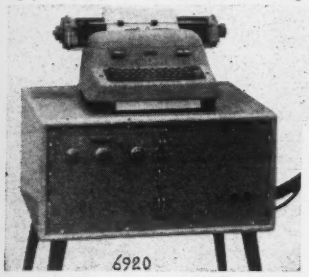
New "All-Purpose Computer" is said to be "a new concept in electronic computers, for the first time combining in one low-cost unit (*A*) a general-purpose digital computer with (*B*) a digital differential analyzer for application to problems of research and control." It is available as *A* only, or with *B*. Extremely flexible programming system has permitted creation of simplified interpretive subroutines whereby inexperienced persons can prepare problems for solution. (A library of these subroutines is available to users.) Options: up to four mag-tape units each with 300,000-word storage; graph plotter and follower, etc.—*Bendix Computer Div., Bendix Aviation Corp.*, 5630 *Arbor Vitae St., Los Angeles* 45, *Calif.*

For more information circle **245** on inquiry card.

OSCILLOGRAPH DATA REDUCTION SYSTEM

New "Oscar Model J" is especially advantageous to smaller lab, because of its extreme flexibility and low cost; handles either film or opaque records: linear or non-linear calibrations; automatic readout to electric typewriter and card or tape



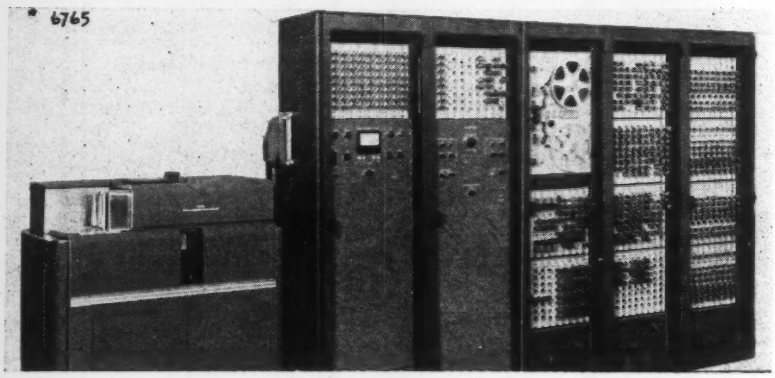


punch machines; accuracy 0.1%; readout initiated in less than 0.15 seconds after depression of readout switch. System contains no vacuum tubes, transistors or diodes. Option: designed for mounting in a mobile van.—*Benson-Lehner Corp.*, 11930 *Olympic Blvd., Los Angeles* 64, *Calif.*

For more information circle **246** on inquiry card.

MULTI-CHANNEL DATA-REDUCTION SYSTEM

New "Datrac C" 18-channel simultaneous sampling system reduces bipolar input voltage data into magnetic tape and IBM punch-cards; is suitable for a wide variety of data reduction applications. Among features: (1) Multiple input ranges from ± 10 mv full-scale to ± 1000v full-scale; (2) Over-all system accuracy: relative 0.025%, absolute 0.1%; (3) Effective sampling time for 18 input channels: 0.25 usec; (4) up to 180 data points per sec; (5) Incoming



New 350

A SUPERIOR LOW-FREQUENCY INSTRUMENT BY

DU MONT

The Type 350 combines the best features of all previously available low-frequency instruments. It is an entirely new low-frequency instrument that *must* be seen to be appreciated

Identical X- and Y- amplifiers permit accurate measurements up to 150 KC. Identical phase response between the two amplifiers allows accurate phase-shift measurements of minute phase differences. Internal calibration is provided for both amplifiers.

Stability-wise, the Type 350 has no peer. Regulation of all circuits, including the filaments, permits accurate measurements over many hours. The illuminated, calibrated scale assists in measurements. High accelerating potential permits operation with long-persistence screens.

Modern hard-tube sweep circuit provides superior linearity with beam gate for forward trace brightening. This sweep circuitry eliminates practically all time distortion over the range of sweeps from ½ sec/inch to 2 usec/inch.

These and many other new features make the Du Mont Type 350 the standard of performance in low-frequency oscillography.
Write for complete technical details...

Price $395

DU MONT

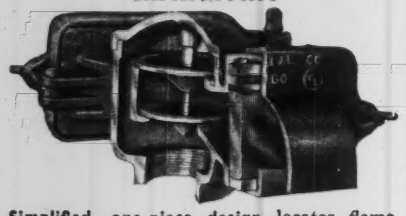
TECHNICAL SALES DEPARTMENT
ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J.

For more information circle **82** on inquiry card.

PROTECTOSEAL
vapor conservation vents
DESIGNED FOR . . .

LOW-COST MAINTENANCE

FULLY FIRE PROTECTIVE
SIMPLE and EASY to MAINTAIN



Simplified, one-piece design locates flame arrester outside pressure-tight housing where it is easily accessible.

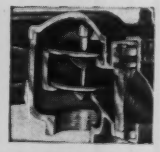
Vertical position of arrester permits condensate to drain off freely—prevents frequent "clog-ups" and prolongs operating time.

Modern "swing-bolts" permit quick removal of vent covers for visual inspection or removal of valves or arresters for cleaning.

Interchangeable arresters permit a spare to be inserted quickly and easily to safeguard tank while servicing original arrester.

Sturdy arrester plates resist distortion during cleaning and are self-positioning to assure correct air-space-gauging and safe reassembly to original Factory Inspection Standards.

Precision fabricated valves are processed to assure tight seatings, and are available as specified on order for other than normal pressure settings. Stream-lined design assures maximum air-flow capacities and self-drainage of condensate.



SEE CHEMICAL ENGINEERING CATALOG, PAGE 1503

West Coast Warehouse: Los Angeles, Calif.
In Canada: Safety Supply Co., Toronto

The Protectoseal Company
1954 So. Western Ave., Chicago 8, Ill.
Please send me "Venting Fundamentals"
Name_____ Title_____
Company_____
Address_____
City_____ Zone___ State_____

For more information circle **83** on inquiry card.

NEW INSTRUMENTS

data can be visually monitored during data run; (6) System is entirely automatic and it checks accuracy of the data being transferred from mag-tape to punch-cards. (7) Standard-cell automatic internal reference.—*Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.*

For more information circle **247** on inquiry card.

COMMON LANGUAGE MACHINE

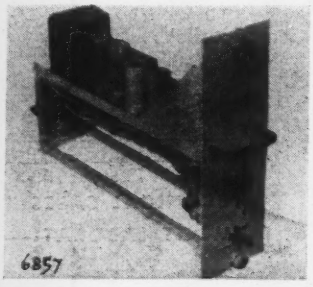
New "Databosser V100-EW" high-speed data processing machine automatically sets type and embosses

metal plates for identification, writing or addressing, while simultaneously performing four auxiliary operations to prepare plates for industrial systems and control procedures; is adaptable to integrated data processing; is actuated and cycled by punched cards, punched tapes or magnetic tapes. When cycled for repetitive production, equipment delivers up to 6000 completed plates per hour; when actuated by punched cards or tapes its average is about 1000 different plates per hour.—*Dashew Business Machines, Inc., 5886 Smiley Drive, Culver City, Calif.*

For more information circle **248** on inquiry card.

CONTROL AND COMPUTER COMPONENT COMBINATIONS

Four new component combinations of "Servomation*. Building Blocks" (a correlated modular array of electromechanical general-purpose analog



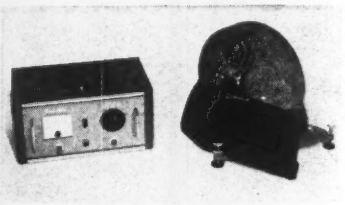
computer components) provide means for industrial control, problem solving, and data processing: "2315" *modulator* modulates a dc control system with a 300 to 2,000 cps carrier; "2317" *tachometer modulator*" modulates dc signals to modulated 400-cps signals, can be used to introduce stabilizing signals from dc tachometers into ac servo loops; "2306" *demodulator*, as a bridge-type 400-cps demodulator, converts modulated carrier signal into dc signal required by dc corrective or equalizing networks; "2316" *corrective network* to shape transmission characteristics of a dc servo loop or, with "2315" and "2306," for ac loops.—*Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **249** on inquiry card.

PHOTOGRAPHY

HIGH-SPEED DRUM CAMERA

New "Model 224" is a general-purpose research camera capable of transporting film at high velocities for lab-

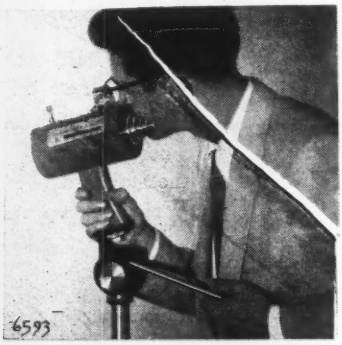


oratory or field experimentation. As a CRO camera, for instance, it offers writing speeds from 4 to 400 feet of film per second. Full line of available accessories permits its use as a streak camera, or, using a pulsed-light source, as a framing camera.—*Beckman & Whitley, Inc., 930 E. San Carlos Ave., San Carlos, Calif.*

For more information circle **250** on inquiry card.

PHOTOMETER

New "Servotherm UV-I8 Photometer Model 1370" helps photographer by doing away with meter errors



due to temperature changes, blanket film speed ratings, fixed field of view and low sensitivity (as well as his own faults in exposure calculations and filter corrections); covers a wide

How to Control Heat in a Large Oven

No. 4 of a series — *Showing the Broad Application Range of Fenwal Controls*

The oven is designed to dry 30 yards of finished goods per minute at oven temperatures up to 400°F. The problem was to maintain the desired 330°F in the oven. Here's how this was accomplished —

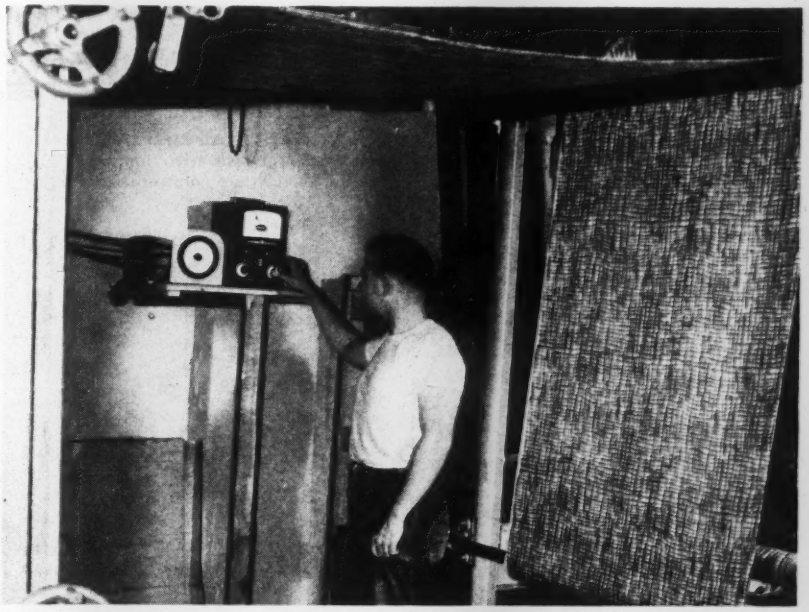
The many electric heaters, which are distributed uniformly in the oven, provide a total heat input of about 60,000 watts and are divided into two separate control circuits. About one-third of the heaters are controlled by a simple on-off controller of moderate sensitivity to maintain a basic heat level in the oven. The remaining heaters are operated by the Fenwal Series 560 Portable Temperature Indicating Controller, an instrument of high sensitivity and rugged construction. The Series 560 provides the proportioned heat necessary for accurate control of the curing process. It also can be used for straight on-off control. Here's the way the control set-up works —

To maintain the desired 330°F in the oven, the on-off controller is set at 315°F, while the proportioning controller is set at 330°F. So both heater circuits are on during oven warm-up or when incoming fabric depresses the oven temperature below 315°F. Above 315°F, the on-off controller shuts off the heaters in its circuit, and the process heat is obtained from the remaining heaters under the control of the Fenwal Series 560 Controller.

Integrated Sensitivity a Big Advantage in The Series 560

In the Fenwal Series 560 Temperature Indicating Controller the superior thermoelectric qualities of the revolutionary thermistor are used to fullest advantage. The great resistance change of the thermistor in response to temperature change results in extreme sensitivity. It also enables the use of a simple null balance bridge circuit for increased stability. And it permits the use of a standard electric conductor as a connecting wire — *no special wire is required.*

These characteristics have been *integrated* by Fenwal into a rugged, durable instrument which is the first to combine all three major modes of indicating control — on-off, proportional and adjustable differential — *all functioning with high sensitivity at the flip of a switch.*

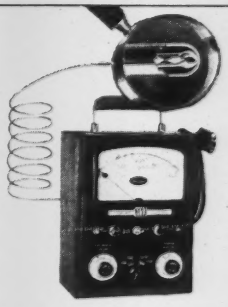


THIS 600 CUBIC FOOT CURING OVEN, planned and installed by Atlas Textile Machinery Co., Paterson, N. J. at the Gsell Textile Printing Corp. plant in New York, uses the Fenwal Series 560 Portable Temperature Indicating Controller to provide uniform drying conditions within 2 degrees of the set point.

Proved Applications

Fenwal Sales Representatives and Engineers have saved time, trouble and money in all types of plants and laboratories by solving thousands of temperature control and detection problems. Fenwal THERMOSWITCH® units are controlling processes that involve liquids, gases and solids.

Put Fenwal's vast reservoir of technical know-how to work for you. Chances are your problem has already been met and mastered by Fenwal engineers. Write for Catalog No. 500 for complete information.



SERIES 560 INDICATOR CONTROLLER with magnified cutaway view of thermistor probe.

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Please send me your Catalog No. 500. Our specific problem is:.....

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.....

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City.....*Zone*...*State*.....

Fenwal CONTROLS TEMPERATURE . . . *PRECISELY*

For more information circle **84** on inquiry card.

BARBER COLMAN **d-c motors**

compact, powerful high quality for a wide range of applications

Looking for a d-c fractional hp motor of unusually high quality, high dependability? Specify Barber-Colman, the *versatile* line of small motors in both permanent magnet and split series types . . . in various mountings and speeds, and outputs up to 1/10 hp. Ideally suited to power electro-mechanical actuators, switches, blowers and programing devices. Barber-Colman small d-c motors are also available with lightweight radio noise filters to meet radio interference requirements of USAF. They are ideally suited for use as tachometer generators. Whatever your problem involving small motors, consult Barber-Colman Company for an expert solution.

Write for free catalog No. 100

BARBER-COLMAN COMPANY

Dept. D, 1415 Rock Street, Rockford, Illinois

For more information circle **85** on inquiry card.

NEW INSTRUMENTS

range (0.3 to 3.0 microns). Selective fields of view (7°-50°) permit distant measurement of entire picture or specific highlights.—*Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **251** on inquiry card.

TELEPHOTO LENS

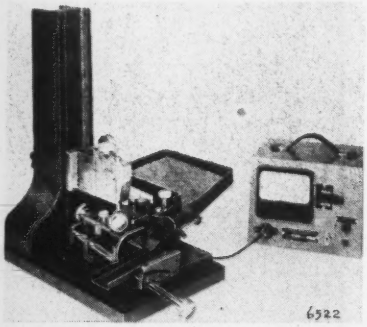
New "Alefar" 180mm f/4.5 with preset diaphragm for "Alpa" 35-mm single-lens reflex camera is a true 4-element telephoto lens. Click-stops range from f/4.5 to f/32.—*Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.*

For more information circle **252** on inquiry card.

DIMENSIONAL GAGING and INSPECTION

BEARING-BALL GAGE

New bearing-ball-measurement attachment, for use with maker's "Micro-Ac" electronic comparators, gages



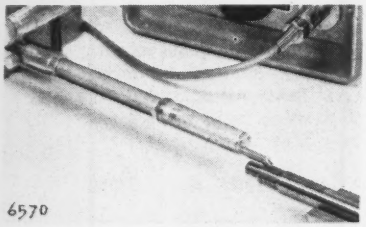
balls from 1 mm to 1½" diameter to accuracy of 0.5 microinch; can be used also for sphericity gaging of other objects.—*Cleveland Instrument Co., 735 Carnegie Ave., Cleveland, Ohio.*

For more information circle **253** on inquiry card.

SURFACE-ROUGHNESS TRACER

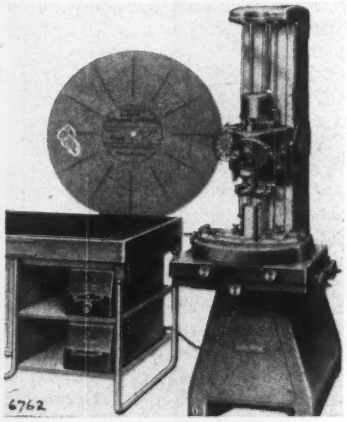
New "Profilometer Type LJ Tracer" can measure more than 85% of all industry-produced surfaces; can be operated by "Mototrace" or by hand; can be used with any "Profilometer Amplimeter" and "Mototrace." Its versatility is made possible by having tracer point at end of a projecting beam, and by three interchangeable "Skidmounts" that support tracer on work surface. —*Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.*

For more information circle **254** on inquiry card.



ROUNDNESS RECORDER

New "Talyrond" electrically measures roundness of parts such as balls, rollers, pistons, cylinders, bearing races, etc., and produces test graphs. Radial magnification variable from 50 to 10,000 depending on depth below top of work.—*Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.*

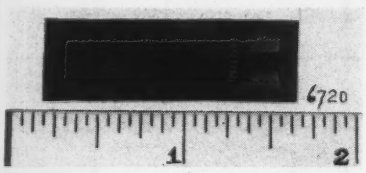


For more information circle **255** on inquiry card.

MECHANICAL TESTING

FOIL-TYPE STRAIN GAGES

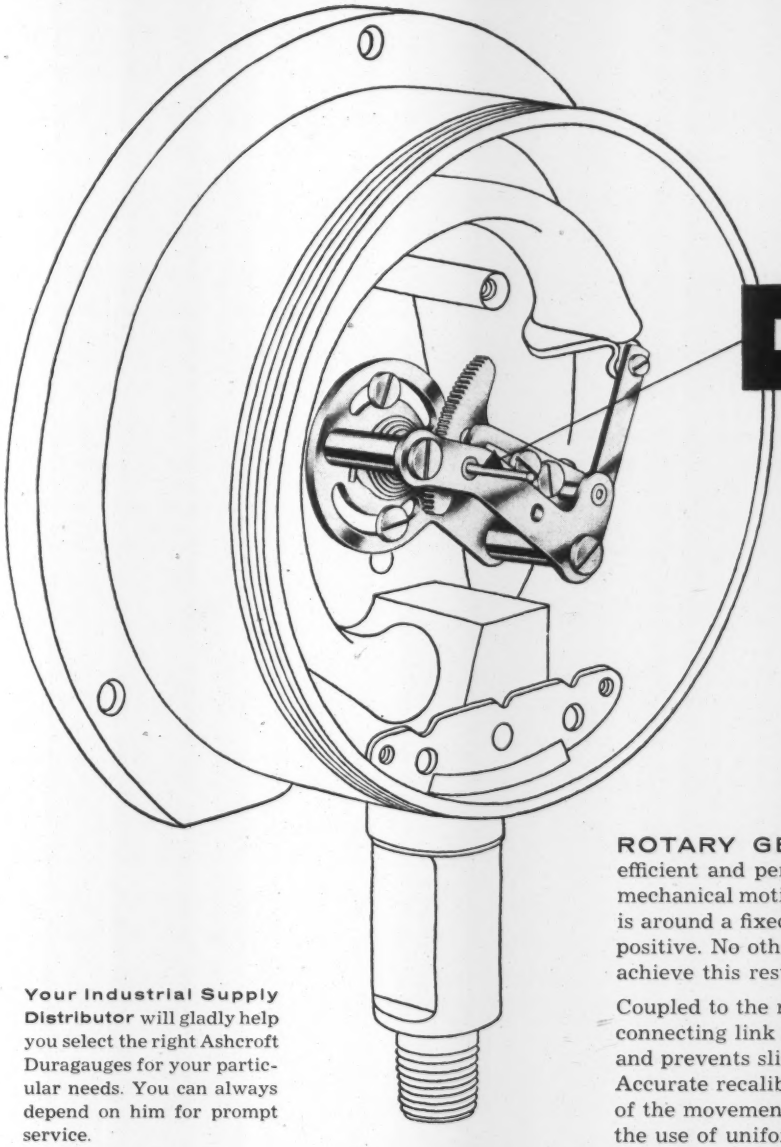
New bonded resistance type strain gages made of metal foil for use at normal atmospheric temperatures are offered for experimental and trial use on a no-guarantee basis, in kits including 20 gages, cement, working tools, and instructions. They consist of a 0.0005" thick Cu-Ni foil grid on epoxy resin backing; nominal resistance 119 to 121 ohms; gage factor about 2.20; application procedure about same as for "SR-4" wire gages. —*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*



For more information circle **256** on inquiry card.

STRAIN-GAGE INDICATOR

New "SL-1002" servo-driven indicator, designed to measure output of conventional strain gages, comprises an indicator, servo amplifier, and control box; is self-contained; oper-



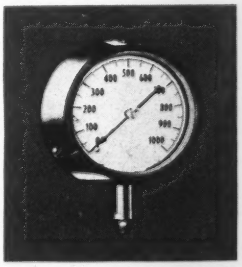
Why does the MOVEMENT in the ASHCROFT DURAGAUGE outperform all other types?

ROTARY GEARED MOTION, the most efficient and perfect method of transmitting mechanical motion ever developed. Because rotation is around a fixed center, pointer position is always positive. No other type of movement can ever achieve this result.

Coupled to the movement is a one-piece connecting link that guarantees correct calibration and prevents slippage or parting under tension. Accurate recalibration is easy from front or rear of the movement. Universal adjustability permits the use of uniformly graduated dials, thereby facilitating maintenance.

The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. There are case designs and materials, Bourdon tube materials, pressure ranges and dial sizes to meet your service conditions exactly. Save time, trouble and money. Specify the pressure gauges of highest sustained accuracy and durability – Ashcroft Duragauges.

Your Industrial Supply Distributor will gladly help you select the right Ashcroft Duragauges for your particular needs. You can always depend on him for prompt service.



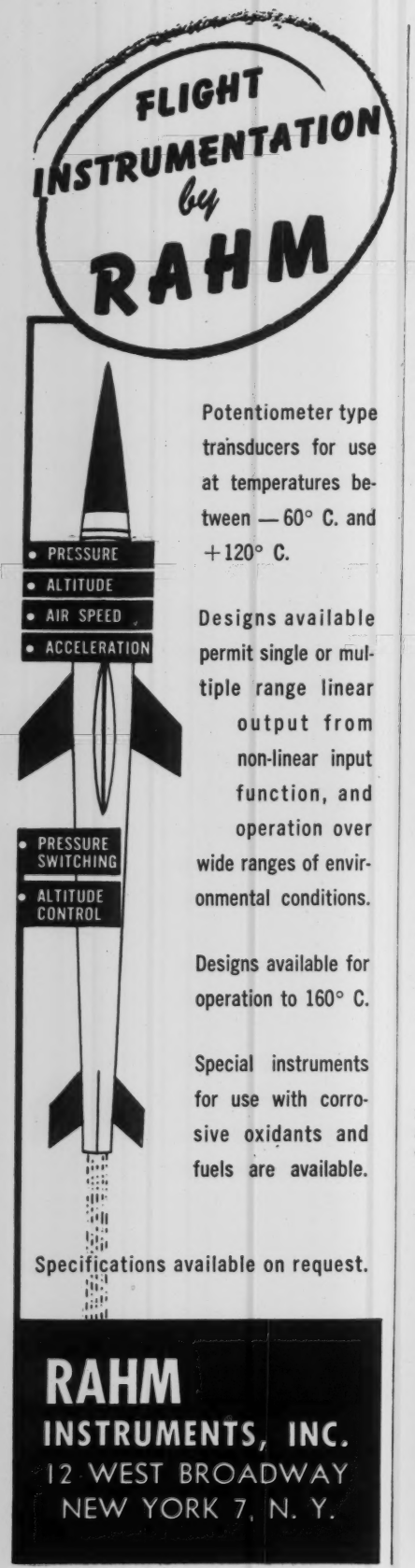
In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more information circle **86** on inquiry card.



Potentiometer type transducers for use at temperatures between — 60° C. and +120° C.

Designs available permit single or multiple range linear output from non-linear input function, and operation over wide ranges of environmental conditions.

Designs available for operation to 160° C.

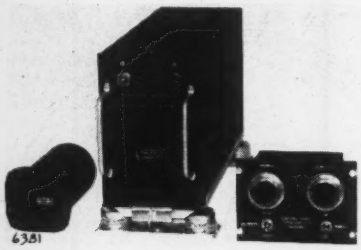
Special instruments for use with corrosive oxidants and fuels are available.

Specifications available on request.

RAHM
INSTRUMENTS, INC.
12 WEST BROADWAY
NEW YORK 7, N. Y.

For more information circle **87** on inquiry card.

NEW INSTRUMENTS

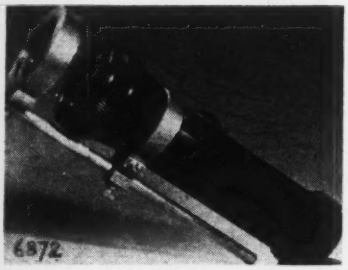


ates from 117-v 400-cps line. Features are digital counter presentation, small indicator size, 0.2% linearity, and novel gage circuit minimizing drifts due to unbalanced thermal emf's. Especially useful where many indicators must be photographed together.—*Industrial Control Co., Wyandanch, L. I., N. Y.*

For more information circle **257** on inquiry card.

PORTABLE POLARISCOPE

New qualitative polariscope has been designed for convenience and ruggedness as a strain detector. In



such service its efficacy is exactly the same as that of any other type of full-color polariscope, with advantage of extremely low cost.—*Tube Light Engineering Co., 427 W. 42nd St., New York 36, N. Y.*

For more information circle **258** on inquiry card.

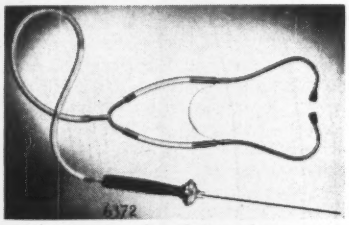
SIDEREAL TEST TABLE

New high-precision test platform for nulling earth rate in gyro test and similar applications utilizes change gears whereby various multiples of sidereal speeds are available. A second motor provides rotation of 25" dia table in fractional-rpm range. Accuracy one part per million (based on accuracy of frequency control).—*J. W. Fecker, Inc., 2016 Perrysville Ave., Pittsburgh 14, Pa.*

For more information circle **259** on inquiry card.

MACHINE "STETHOSCOPE"

Newly redesigned "Multiscope" is 39.4% more sensitive than older model; is tuned to frequency range of

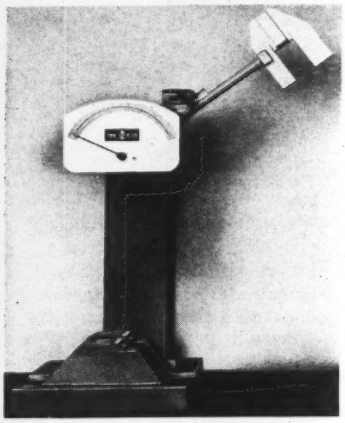


human ear. It pinpoints noise sources and saves hours in locating and analyzing such conditions as worn gears, and bearings, loose pulleys, piston slap, leaky valves.—*Herbrand Tools, Fremont, Ohio.*

For more information circle **260** on inquiry card.

IMPACT TESTER

New single-purpose 120-ft-lb-capacity Charpy Impact machine provides high testing accuracy and meets all



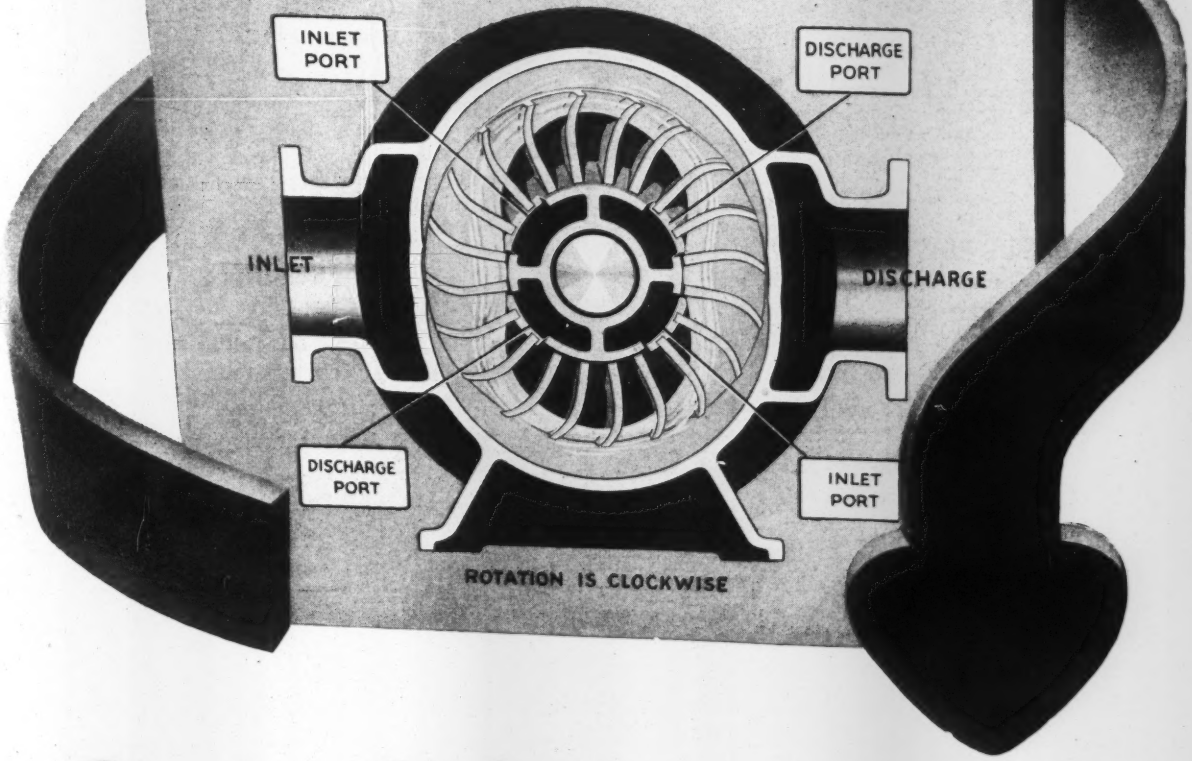
government requirements for normal and cold temperature testing. It minimizes deflections and eliminates variables by transmitting impact action directly to heavy base.—*Tinius Olsen Testing Machine Co., Willow Grove, Pa.*

For more information circle **261** on inquiry card.

RUNNING TORQUE TESTERS

New "Type #200 and Type #300 Running Torque Testers and Dynamometers" have an accuracy of 0.25%; comprise five models to test motors up to ¾ hp at up to 10,000 rpm. Their dynamometers have 10" torque dial; torque-measuring component utilizes "Iso-Elastic" springs which compensate for temperature variations from 0 to 150°F. Hysteresis brakes dissipate motor heat, have

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

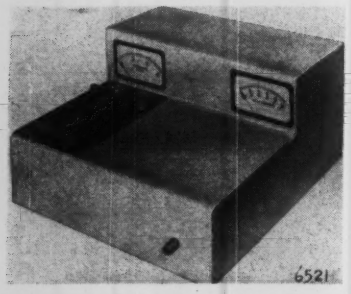
®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY

378 WILSON, SO. NORWALK, CONN.

NEW INSTRUMENTS

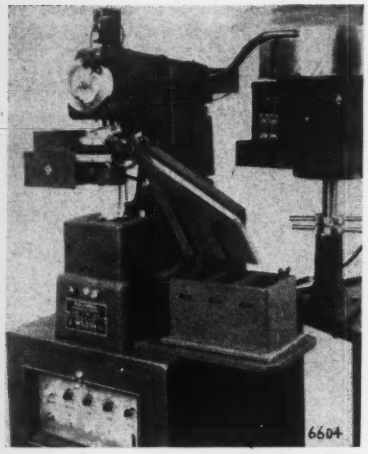


high power absorption, low inertia, also allow torque to be held at 0 rpm for start and stalling torque and testing torque wrenches and screw drivers.—*John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.*

For more information circle **262** on inquiry card.

AUTOMATIC HARDNESS TESTER

New fully automatic Rockwell hardness tester with vibratory feed, can test about 1,000 parts per hour. After

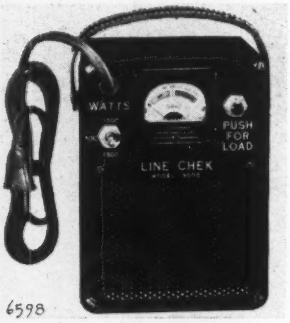


testing, parts are routed into bins labeled HARD, GOOD and SOFT. Colored lights show classification of each part as it is being tested.—*Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.*

For more information circle **263** on inquiry card.

LINE CHEK

New "Model 3000" checks condition of line under load and enables user to connect an electrical load equal to

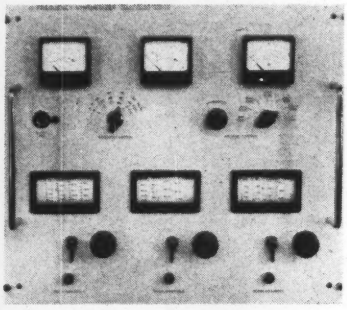


appliance to be installed on line.—*Triplett Electrical Instrument Co., Bluffton, Ohio.*

For more information circle **267** on inquiry card.

FREQUENCY SYNTHESIZER

New "Type FT-XUA" generates a single frequency which is continuously variable from 30 cps to 30 Mc and



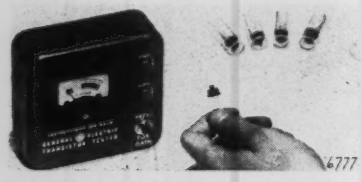
which is so accurate and stable that it can be used as a laboratory frequency standard; features simplicity of operation so that non-skilled personnel can use it with speed and proficiency.—*Instrument Div., Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N. J.*

For more information circle **268** on inquiry card.

ELECTRICAL TESTING

TRANSISTOR TESTER

New inexpensive two-scale portable transistor tester, expected to be a boon for radio and TV service tech-

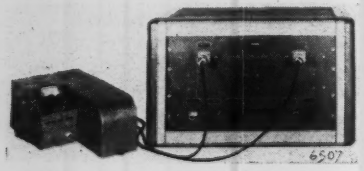


nicians and hobbyists, checks all types of junction transistors for short circuits, opens, leakage and current gain; has separate plug-in sockets for *n-p-n* and *p-n-p* transistors; is sold with five universal replacement transistors and a transistor interchangeability chart by authorized G-E tube distributors.—*General Electric Co., Electronics Park, Syracuse, N.Y.*

For more information circle **264** on inquiry card.

SEMICONDUCTOR TESTER

New "Model JJ1" Minority Carrier Lifetime Test Set for Semiconductors utilizes principle of conductivity modulation. Light, used to inject the excess carriers, is allowed to fall on an etched semiconductor with two ohmic leads. Sample is biased by a small di-

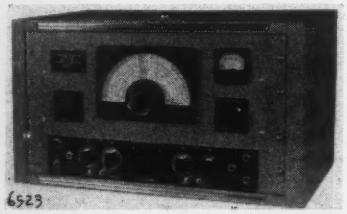


rect voltage. Light pulse changes sample's conductivity with a resultant decrease in voltage drop. When light pulse is removed from sample, excess carriers recombine at an exponential rate. Resultant curve is displayed on a CRO. Average life of excess carriers can be determined by observing curve (equal to half decay time divided by natural log of 2). This information is basic: it foreshadows a material's performance characteristics such as frequency, current gain, and material uniformity.—*Baird Associates, Inc. 33 University Rd., Cambridge 28, Mass.*

For more information circle **265** on inquiry card.

VERSATILE OSCILLATOR

New "Model 1440-D" provides low-distortion single-, two-, or three-phase signals over frequency range of 50

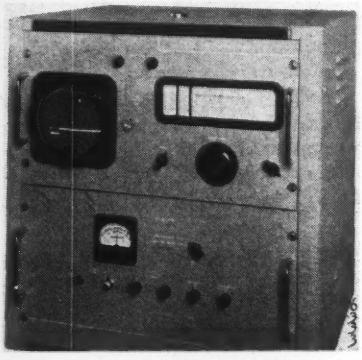


to 6000 cps. Displacement between phases is adjustable from 0 to 360° Output level is 5 v maximum across 6000 ohms. "Test" jack allows visual monitoring of output signals and improved metering circuit allows measurement of both "phase" and "phase-to phase" voltages.—*Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N. J.*

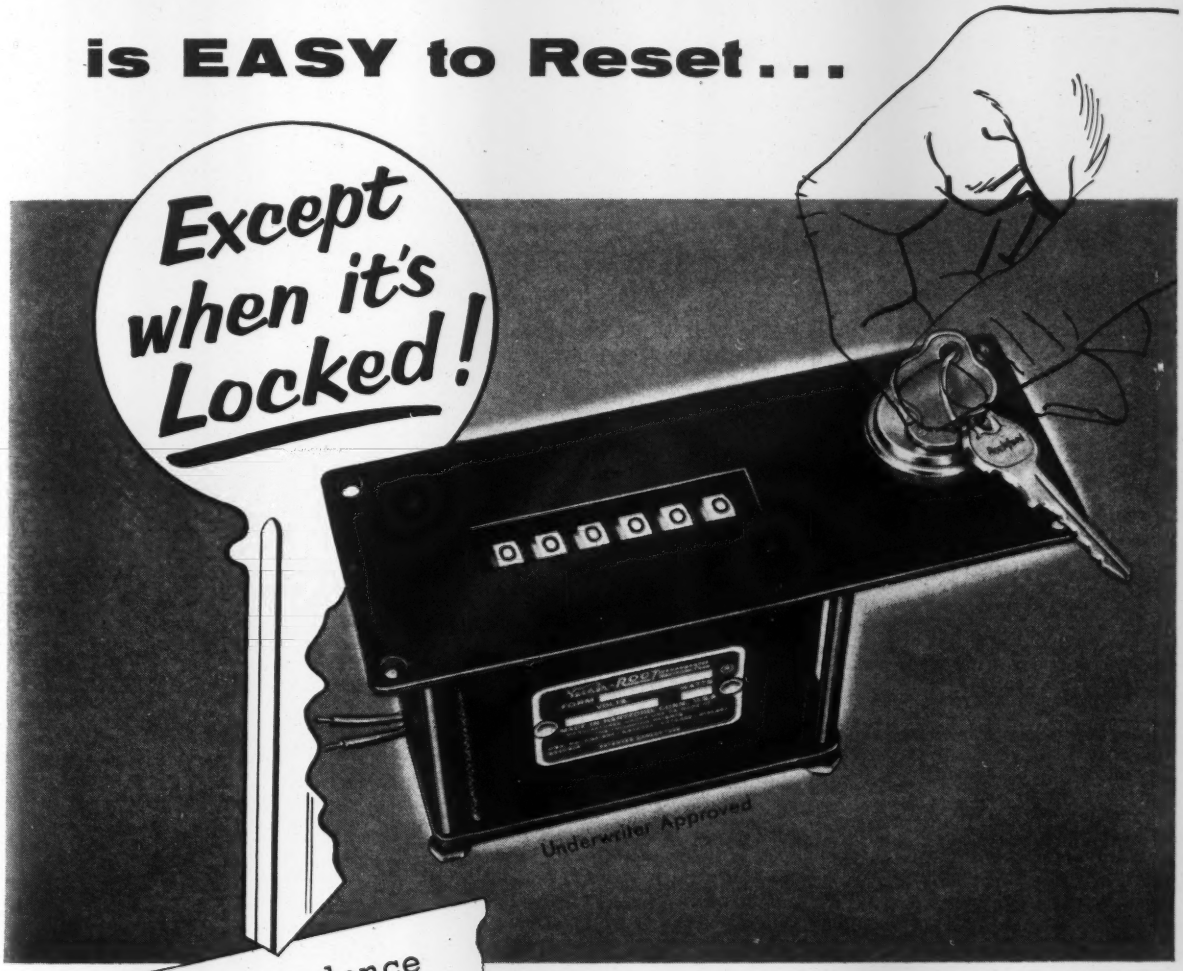
For more information circle **266** on inquiry card.

PANORAMIC RECEIVER

New "Model PAN-1" covers range from 100 to 150 Mc, features three controllable inductor-tuned rf stages in a double-superheterodyne circuit



This NEW Magnetic Counter is EASY to Reset...



Added Evidence that—

Everyone Can Count on VEEDER-ROOT

Designed for panel mounting where remote indication is required, this electrically operated counter is a compact package 5.5″ long, 2.1″ wide, 2.7″ high. Capacity: 1,000 counts per minute. Power consumption, 8 watts. Stocked in 110 and 220 AC and DC. Easy to reset, except when locked . . . then the sturdy tumbler-lock* puts the damper on tampering. Yet one turn of the key resets all 6 figures to zeros.

This new Magnetic Counter is one of the thousands of Veeder-Root standard and special counters . . . electrically, mechanically and manually operated . . . in daily use throughout the world in industry, business, science and medicine. You, too, can count on Veeder-Root . . . to help you count anything you need.

*National Lock Co. Lock No. 68-4837; Key D-428

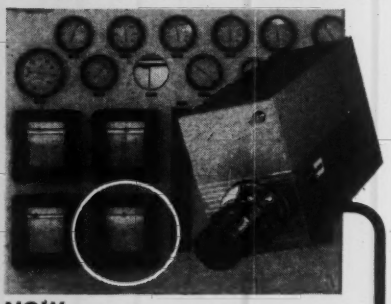
Stocked at
Hartford 2, Conn. • New York 19, N. Y.
Greenville, S. C. • Chicago 6, Ill.
Montreal 2, Canada
Offices and Agents in Principal Cities

VEEDER-ROOT
"THE NAME THAT COUNTS"

For more information circle **88** on inquiry card.

KAY LAB

CLOSED CIRCUIT TV PIONEERS



NOW . . .

YOU CAN USE INDUSTRIAL TV

• EXTEND YOUR VISION •

KAY LAB'S small camera flashes images from remote points and dangerous operations to a central location . . .

VIEW: Production schedules, charts, blueprints, gauges, meters, flames, smokestacks . . .

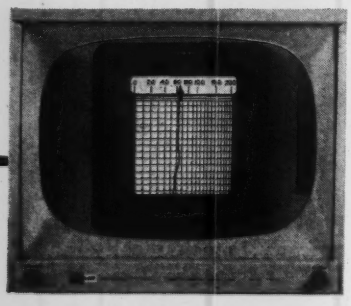
OBSERVE: Gates, loading docks, storerooms, manufacturing operations . . .

USE: For plant tours and training, time and motion studies.

TRULY A "TELEVISION INTERCOM"

KAY LAB TV IS UNEQUALLED

for laboratory performance combined with rugged durability, simplicity, economy . . . our nationwide staff of field engineers has experience in hundreds of installations . . .



Write or wire today for descriptive literature and demonstration

KAY LAB

5725 KEARNEY VILLA ROAD
SAN DIEGO 12, CALIFORNIA

For more information circle 89 on inquiry card.

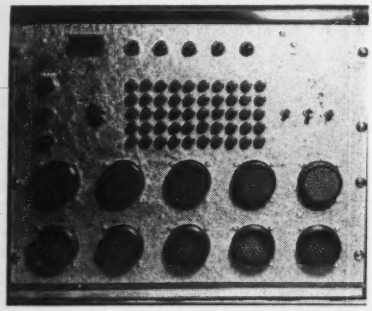
NEW INSTRUMENTS

which provides more than 60-db attenuation of all spurious responses and a noise figure no greater than 13 db throughout tuning range. Seven tracked "Increductor Controllable Inductor" tuned circuits operate without moving parts to provide vibration-free operation and virtually unlimited life. Received signals are displayed logarithmically on a 5" flat-face CRT (dynamic range of 60 db presented as 6-to-1).—*CGS Labs*, 391 *Ludlow St., Stamford, Conn.*

For more information circle **269** on inquiry card.

CONTINUITY TESTER

New Continuity Tester tests automatically up to 200 conductors in groups of 50 in any given cable or

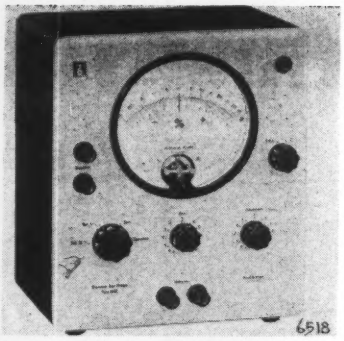


harness assembly; uses stepping switches of telephone variety to provide automatic switching from one circuit to another. In case of failure, tester will stop on defective circuit with a numbered lamp indicating it. Tester will check through a cable of 50 conductors in one second.—*Century Engineers, Inc., Burbank, Calif.*

For more information circle **270** on inquiry card.

DEVIATION TEST BRIDGE

New "Model BL-1506" speeds repetitive bridge type measurements; has a 100-kc bridge frequency for test ranges 10 to 50,000 ohms resistance, 25 mmfd to 0.1 mfd capaci-



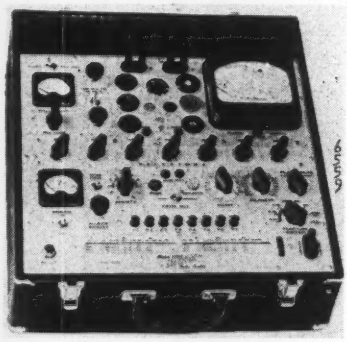
6518

tance, and 20 microhenry to 80 millihenries inductance. ★Companion "Model BL-1504" has a 1-kc test signal. ★"Knee-Operated Test Jig Accessory BL-3901" greatly facilitates manual inspection procedures.—*Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland, Ohio.*

For more information circle **271** on inquiry card.

TUBE TESTER

New "Model 539-B Standard Engineers' Portable Tube Tester" is said to furnish "the most complete and



most accurate evaluation of an electron tube ever possible in a commercial type portable."—*Hickok Electrical Instrument Co.*, 10528 *Dupont Ave., Cleveland* 8, *Ohio.*

For more information circle **272** on inquiry card.

ELECTRICAL INSTRUMENTS

DIGITAL VMs WITH AUTOMATIC CONTINUOUS CALIBRATION

New improvement in maker's digital voltmeters is announced. Measurement is accomplished by comparing unknown voltage with a stable reference which is incrementally varied by automatically switching precision resistor decades in a Wolff-bridge circuit. Formerly, calibration was done manually. Now, voltmeters are continuously calibrated automatically. Stability is 0.01% from 40° to 125° F with 30 seconds warm-up time required for 0.01% accuracy. Input impedance is 1,000 megohms on lowest scale and 11 megohms on other scales. —*Electro Instruments, Inc.*, 3794 *Rosecrans Ave., San Diego* 10, *Calif.*

6536

For more information circle **273** on inquiry card.

AMPLIFIER-INDICATOR

New "Type FT-UBM Tunable Indicating Amplifier" is said to be "ideal for use as a null detector for AF and RF test bridges and other applications." Variable tuning from 45 cps to 400 kc (with bandwidth adjustable

WHY ENGINEERS FEEL AT HOME AT ROCKETDYNE

First and foremost, ROCKETDYNE talks your language—and understands it too. Your associates and supervisors here are professional people like you. They respect your status, your thinking, your ideas and your interest in technical advancement.

ROCKETDYNE will encourage you to choose the field that is most satisfying and rewarding... truly best for you. This is possible because its activity includes the full range of rocket engine development from preliminary design to field testing and production... because its programs include development of the largest liquid-propellant rocket engine in the Western World... because it has contracts with all branches of the Armed Services and the guided missile industry for broad variety of rocket engine types and sizes.

It may surprise you to know you can qualify for a career at ROCKETDYNE *with or without specific rocket engine experience!* Engineering experience in heating and ventilating, hydraulics, pumps, turbines, combustion devices, controls, dynamics, structures and instrumentation are just a few of the related fields that could open your future at ROCKETDYNE.

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ROCKETDYNE is North American's rocket engine division. It has just moved into new ultra-modern headquarters in Canoga Park, located in the beautiful West San Fernando Valley of Los Angeles. This area is famous for its fine residential sections, modern shopping-center convenience, varied recreational and entertainment facilities. Any point in the San Fernando Valley is just minutes drive from the beaches, and the weather is pleasant all year around. Many engineers are interested in advanced courses offered by fine schools like UCLA, USC and Cal Tech, all within a short drive from our headquarters.

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DESIGN & DEVELOPMENT ENGINEERS
Mechanical, Chemical, Electrical, Aeronautical, Standards, Structural and Stress. For rocket engine components and systems design or development. Turbine, pump, controls and combustion device experience preferred.

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Experienced on engine systems, combustion devices, turbines, pumps and engine instrumentation.

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Electrical, mechanical, structural, industrial. For design of facilities, specialized test, and handling equipment.

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To analyze rocket engine control systems utilizing electronic analog and digital computers, B.S., M.E., or B.S.E.E. necessary. Prefer advanced degree. Experience in servomechanisms, systems analysis desired.

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To analyze, design and develop high speed subsonic and supersonic turbines. Jet engine or industrial steam turbine experience desired.

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Write Mr. Grant Baldwin, Rocketdyne Engineering Personnel, Dept. 596-IA, 6633 Canoga Ave., Canoga Park, Calif.

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

BUILDERS OF POWER FOR OUTER SPACE

An Engineer Speaks Out...

. . . about Remote Heat Control

In many industrial processes, heat control by direct contact is neither possible nor economically feasible. Yet, temperature measurement or control is still an important factor.

We believe we have the solution to this heat control problem in our standard infrared radiation pyrometer systems . . . for these systems measure and control temperature *remotely*.

Our Servotherm® Pyrometer Systems are:

Fast – response time is just .025 or .250 seconds even at the lowest level of sensitivity

Sensitive—temperature variations as small as 0.10° F – or smaller – are detected

Accurate – temperature is maintained within the limits of ±1%

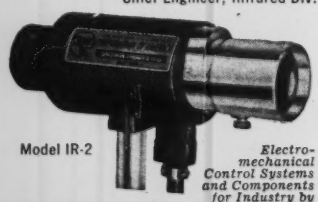
They provide the opportunity for continuous recording. They are flexible. You can install them permanently at a key site or move them from spot to spot. They can be placed as close as two feet from the objects to be measured or as far away as you require.

Servotherm systems are supplying the answers to remote heat control problems in the production of films, plastics, and textiles; in engine design; and in the petroleum industry. One of our systems may provide the answer to your problem.

For the full story on Servotherm Pyrometer Systems, please fill in your name and title in the section below. Attach it to your company letterhead and mail it on to me.

S. N. Howell

Chief Engineer, Infrared Div.



Model IR-2

Electro-mechanical Control Systems and Components for Industry by

SERVO CORPORATION OF AMERICA

S. N. Howell, Dept. HP-2
Servo Corporation of America
20-20 Jericho Tpke., New Hyde Park, L. I., N.Y.
Please send me more information on Servotherm Pyrometer Systems.

Name.....

Title.....

For more information circle **90** on inquiry card.

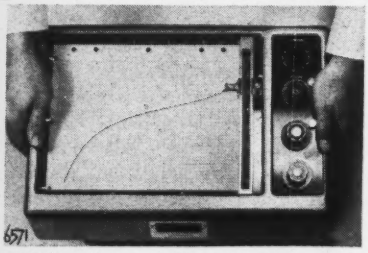
NEW INSTRUMENTS

from 1% to 10%) permits measurements where it is desirable to separate individual signals from harmonics, hum and other spurious voltages. Response is linear for first 10% of scale and logarithmic for remainder, giving a range of indication of better than 40 db on one scale with an additional 80 db available in five steps. —*Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N. J.*

For more information circle **274** on inquiry card.

X-Y RECORDER

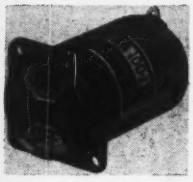
New "Model 3 Autograf," though patterned after "Model 2," is entirely new. It incorporates features of both



"Model 1" and "Model 2"; is smaller, lighter, and more compact but retains their accuracy and versatility. Speeds up to ½ second for full-scale travel, each axis.—*F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena 3, Calif.*

For more information circle **275** on inquiry card.

MINIATURE INDICATOR

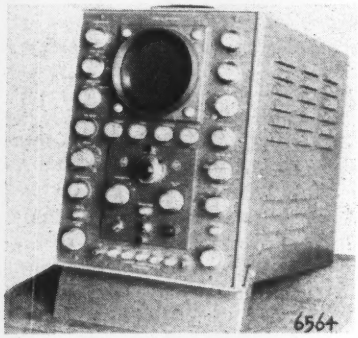


New "Mindicator" hermetically-sealed 13/16" OD indicator features a unique rotating disc dial for maximum display area of colored flags in quadrant-type mask openings of 90° or less whence confusion-proof presentation of alarm, malfunction, position or other information. It can be used with existing instructions lacking such displays, and with one or more devices requiring single or multiple answers. —*Marion Electrical Instrument Co., Grenier Field, Manchester, N. H.*

For more information circle **276** on inquiry card.

C-R OSCILLOSCOPE

New "Easy-Six" is an improved version of "Model 411" featuring increase in HV to 6000 v, greater cool-



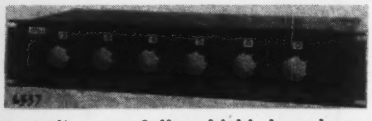
ing capacity and addition of an a-c balance control on front panel. "Six" in new name means six types of 'scopes possible through *X*-axis plug-in units. —*Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.*

For more information circle **277** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

PRECISION VOLTAGE DIVIDERS

Two new precision rack-mounted voltage dividers, "Rackviders Models RV-521 and RV-622" (latter illus-

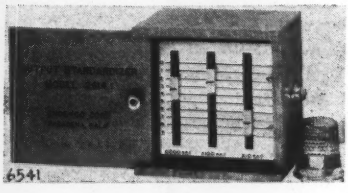


trated), are fully shielded and are usable from dc through 10 kc. Input resistance 10,000 ohms; linearity better than 25 parts per million. "Rackviders" make use of Kelvin-Varley voltage dividing circuit whereby a precisely known output voltage can be obtained with input resistance always remaining constant; are useful for calibration of potentiometers, etc.—*Electro-Measurements, Inc., 4312 S.E. Stark St., Portland 15, Oregon.*

For more information circle **278** on inquiry card.

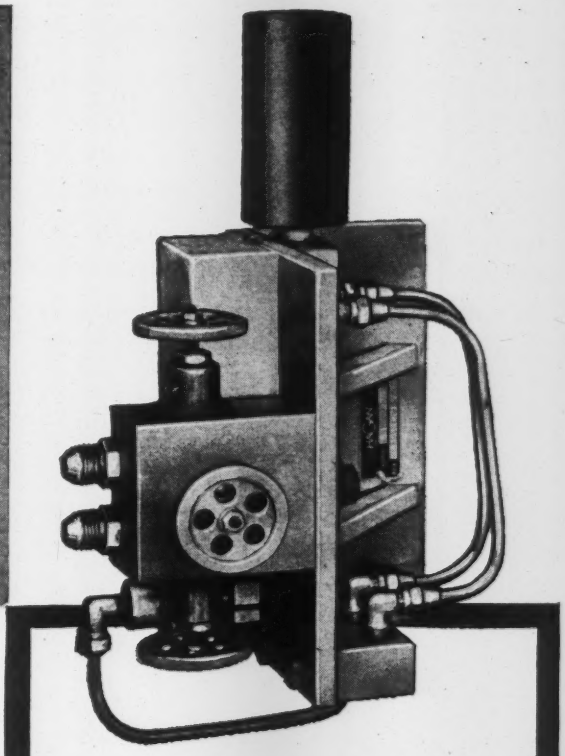
OUTPUT STANDARDIZER

New "Model 2614.1" subminiature decade switch capacitor for telemetering equipment, oscillators, etc., and for reduction of piezoelectric pickup outputs to a "standard" value with improvement of LF response, provides capacitance values from 10 mmfd to 9990 mmfd (±1%) variable in 10-mmfd steps. Groups of pickups can be standardized within 1%. Switch design of small size (1" x 2" x 2") and ruggedized construction is



Accurate, measurement of pressure differentials up to 300 psi

HAGAN DELTA 'P' PRESSURE TRANSMITTER



The Hagan Delta 'P' Transmitter is a sturdy, compact, force-balance instrument for pneumatically transmitting large pressure difference measurements. Consider these features:

1. No stuffing boxes, torque tubes or pressure-tight bearings.
2. Not affected by static pressure changes.
3. Usable at any static pressures up to 3000 psig.
4. Full scale pressure difference measuring ranges from 50 psi to 300 psi with 1% full scale accuracy.
5. Shut-off and by-pass valves integral with instrument.
6. Not damaged by accidental application of full line pressure to either side of measuring element.
7. Stainless steel pressure elements, cadmium-plated steel frame.
8. Shock and vibration proof design.

A few Applications of the Delta 'P' Transmitter

Pneumatic signals from the transmitter are in the range of 0-30 psig, and may be used for indications and records, or for control of factors involved in such functions as:

Pressure difference between steam and boiler feedwater headers.

Steam pressure drop across superheater.

Pressure drop between boiler outlet and turbine throttle.

Pressure drop across high pressure heat exchangers.

Measuring pressure drop across liquid flow control valves for graduated control of pump discharge presssure.

As a "square root" flow meter when pressure differentials are higher than conventional flow meter design.

Measuring pressure differentials for alarm signal purposes under critical operating conditions, such as seal gas pressure during repair periods in a catalytic reformer unit.

HAGAN CORPORATION

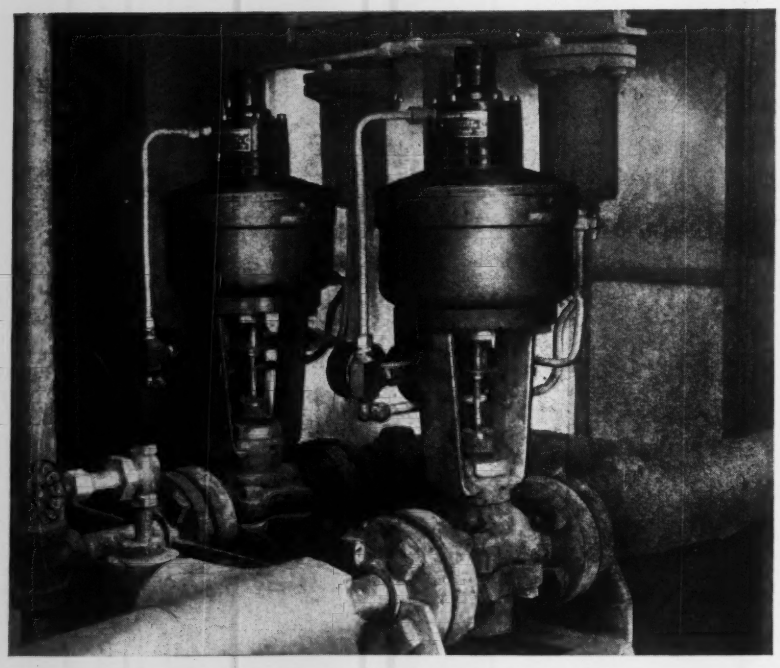
HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN

Systems and Components for: Boiler Combustion Control, Metallurgical Furnace Control, Process Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

HAGAN SUBSIDIARIES: CALGON, INC. • HALL LABORATORIES, INC.

For more information circle 92 on inquiry card.



600 to ONE CUSTOMER PROVES SATISFACTION...

THAT'S THE STORY BEHIND THESE CONOFLOW Series LB CONTROL VALVES

Photo shows an original installation of Conoflow Series LB Control Valves that has been on a temperature control application for several years. There are now over 300 of these valves in operation at this large manufacturing plant. By the end of the year there will be approximately 600 LB valves throughout the plant. Out of respect for our customer's company policy we cannot publish the name. However, the volume of valves involved proves that Conoflow Series LB Control Valves are eminently satisfactory to this prominent user.

The tandem operation shown is a typical application—cooling and heating—utilizing split ranges. One valve handles cold water with a 3-9 psi range. The other handles steam with a 9-15 psi range.

The revolutionary Cylinder Conomotor provides greater speed of response, tight shut-off and other performance characteristics superior to conventional valves. Downtime is practically nil compared with other valves.

Conoflow Controls®
FOREMOST
IN FINAL CONTROL ELEMENTS

Catalog LB-1 tells the complete story of the benefits in Conoflow Series LB Control Valves. Write for your copy. Conoflow representatives are located in most principal cities.

CC-604

CONOFLOW CORPORATION
SUBSIDIARY OF WALWORTH COMPANY
2100 ARCH STREET • PHILADELPHIA 3, PA.

For more information circle **93** on inquiry card.

NEW INSTRUMENTS

suitable for airborne applications. Environmental limitations are those of silver mica capacitors.—*Endevco Corp., 161 E. California St., Pasadena, Calif.*

For more information circle **279** on inquiry card.

INSTRUMENT CHOPPER

New "1200 Series" instrument quality choppers are intended for analog computers, continuous recorders, dc

amplifiers, and servo systems; feature extremely low residual noise in switching circuit; unique lift-off contact that minimizes contact bounce and chatter and extends closure stability over life.—*Vibrapowr Co., 4050 N. Rockwell St., Chicago 18, Ill.*

For more information circle **280** on inquiry card.

POWER SUPPLIES

DRY-CELL REPLACEMENT SUPPLY FOR BRIDGES, ETC.

New "Permavolt Cell," 1.5-vdc power supply operates from 115-v 60-cps line. Output has a long term stability within ¼% against normal line-voltage and ambient-temperature variation. Intended primarily for dry cell substitution in potentiometers to obviate need of frequent standardization, it can be used to advantage also in resistance-thermometer and strain-gage-bridges where a high degree of isolation is essential. Stability and isolation are provided by a magnetic regulating element which depends only on line frequency as a primary reference. "Permavolt Cell" is the exact size and shape of the battery which it replaces, hence can be installed by unskilled personnel without modifying equipment. No. 6 and No. 4FH dry-cell sizes are both available. —*Pace Engineering Co., 6914 Beck Ave., North Hollywood, Calif.*

For more information circle **281** on inquiry card.

POWER SUPPLY CONVERTER

New "Type 3-134" converts 400-cps 3-phase 200 vac to 26 vdc; permits operation of maker's dc oscillographs in

airplanes equipped with ac systems; can also be used to power other dc equipment.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **282** on inquiry card.

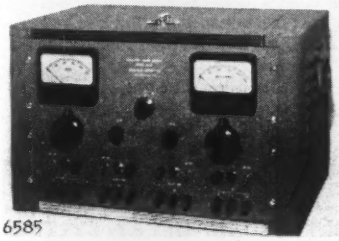
H-V POWER SUPPLY

New "PS-22" electronically-regulated supply, for use with photomultiplier tubes, counters, etc., utilizes a zero-drain thermally-insulated battery voltage reference. Output voltage (500-1000 v) changes less than 0.01% from zero to 1-ma load. A 10% change in input voltage causes less than 0.05% change in output. Ripple is less than 0.003% of output voltage. (All these figures represent maximum values: actual performance, particularly near center of range, is considerably better.) Front panel is standard relay rack mounting 19" by 7"; also available in cabinet for table top mounting.—*Scientific Specialties Corp., Snow & Union Sts., Boston 35 (Brighton), Mass.*

For more information circle **283** on inquiry card.

TWIN REGULATED SUPPLIES

New "Model 3552" has two independent dc supplies. One is a 0-300-v 500-ma unit, the other is 0-500-v 200-



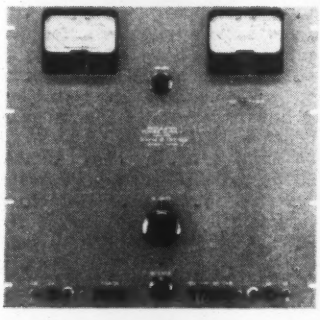
6585

ma; each supply is capable of delivering full rated output current over entire range of output voltage. Also included are two independent 6.3-v 10-amp outputs. ★"Model 3535" twin supply has two dc units identical to the 0-300-v 500-ma supply on "Model 3552."—*Pressman Associates, 7803 Farnsworth St., Philadelphia 15, Pa.*

For more information circle **284** on inquiry card.

PRECISION D-C SUPPLY

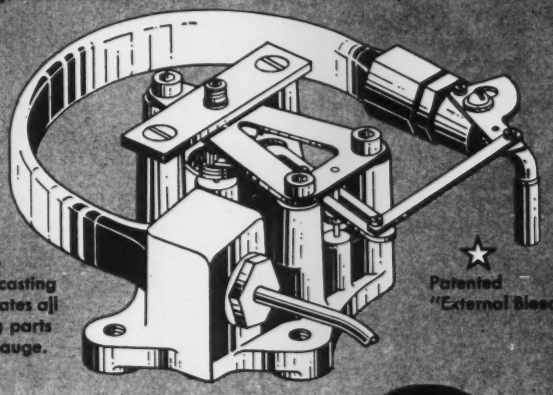
New "Model 1000B," designed for use in instrument calibration, delivers 0 to 1000 vdc at 0 to 500 ma, regulated to 0.1% over full voltage range; bias voltage of 0 to −250 at 0 to 5 ma



HEISE GAUGES

★ Permanent positive accuracy of alignment guaranteed by integral construction.

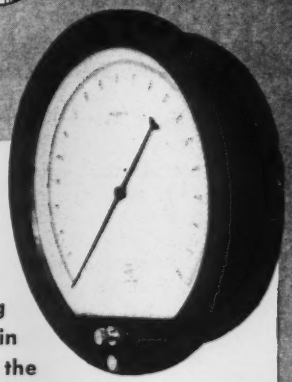
★ Weldless heat treated Bourdon tube maintains precise calibration.



★ Massive Bronze casting coordinates all working parts of the gauge.

★ Patented "External Bleeder"

★ Dial individually engraved with reference to the pressure gradient of its gauge mechanism.



ACCURACY

The standard of excellence maintained by Heise qualifies this instrument for the most exacting requirements. Designed to maintain permanently its inherent precision, the Heise gauge is often used in place of the dead weight tester in checking other instruments. Consistently accurate performance as a calibration reference has established its recognition as THE STANDARD OF THE WORLD.

SPECIALIZATION AND EFFICIENCY

Heise Laboratories have always specialized in the design and production of high precision pressure gauges. The highest standards of quality control protect the manufacture and assembly of each component and the permanent calibration of the finished instrument.

Efficiency in the production of one type instrument, precision pressure gauges, has made it possible to maintain a prompt delivery schedule.

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Pressure Range 15 to 20,000 P.S.I.
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Prices from $151.60

Catalog on Request

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **94** on inquiry card.

to the DIEHL
SERVO MOTOR FAMILY

The Diehl Servo Motor Family is expanding. Rapidly, too—because it's twins this time!

They're not identical twins, to be sure—one's a SIZE 11, the other SIZE 15, 400 cycle a-c induction servo motor—but both are built to exacting specifications, and both have all the fine family traits that mark all the Diehl Servo Motors ranging in power output up to 1 HP. *Fast response . . . more power output . . . long life*—yes, they have all the dependable qualities you look for in the servo motors you specify for automatic control systems.

The SIZE 11, as either a six or four pole motor, has a locked torque (hot) of 0.63 ounce-inches minimum. The SIZE 15 motor, with either eight or four pole winding, has a locked torque (hot) of 1.45 ounce-inches minimum. Check the other specifications below—you'll see how perfectly these new Diehl 400-cycle motors fit into your automatic control picture *today*.

SPECIFICATIONS

Diehl Number	B15M1-1	B11M1-1	Remarks
Government Designation	Mark 7 Mod 0	Mark 14 Mod 2	
Frame Size	15	11	
Number of Phases	2	2	
Reference Phase Volts	115	115	
Control Phase Volts	57½	57½	Parallel connection
	115	115	Series connection
Frequency (c.p.s.)	400	400	
Current Input at Stall	0.110	0.053	Amps. per phase
Power Input at Stall	6.1	3.5	Watts per phase
Impedance at Stall	1030	2175	Ohms per phase
Torque at Stall	1.45	0.63	Oz.-in. minimum
No Load Speed	4800	6200	RPM minimum
Number of Poles	8	6	
Duty at Stall	Continuous	Continuous	
Moment of Inertia	3.3	1.07	Gm/cm ² average
Weight	7.3	4.5	Ounces average

other available components

IA 4-56

A.C. SERVOMOTORS • A.C. SERVOMOTORS WITH A.C. TACHOMETERS • A.C. SERVOMOTORS WITH D.C. TACHOMETERS • A.C. AND D.C. TACHOMETERS • D.C. SERVO SETS • RESOLVERS

Diehl

DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING CO.
Finderne Plant SOMERVILLE, N.J.

For more information circle **95** on inquiry card.

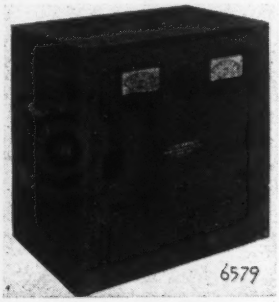
NEW INSTRUMENTS

line estabilized to 0.1 v; fixed bias voltage of −300 v regulated for line and load changes to 0.1 v. By grounding this terminal, "1000B" can function as a 0 to 1300-v supply at 0 to 50 ma. Also an unregulated filament supply of 6.3 vac CT at 8 amp.—*Universal Electronics Co.*, 1720 22*nd St.*, *Santa Monica, Calif.*

For more information circle **285** on inquiry card.

MAG-AMP-REG DUAL SUPPLY

New "Model MR1040-30A" dual voltage range magnetic-amplifier-regulated dc power supply delivers 5-to-



30 v and 10-to-40 v at 30 amp; voltage regulation 1% over both voltage ranges; response time 0.2 sec.—*Perkin Engineering Corp.*, 345 *Kansas St.*, *El Segundo, Calif.*

For more information circle **286** on inquiry card.

ELECTRONIC COMPONENTS

ULTRASONIC DELAY SYSTEM

New "Model 500 Delay Channel" is a solid delay line completely engineered with pre-delay/post-delay circuits and self-contained regulated power supply. Applications: radar, computer, autocorrelation systems, as well as lab use. Video response —3 db below 10 cps above 4.5 Mc; signal to noise ratio 40 db; delay 400 microseconds ±5% (several units can be cascaded for long delays).—*Sturrup, Inc.*, 1 *Factory St.*, *Middletown, Conn.*

For more information circle **287** on inquiry card.

5000-USEC DELAY LINES

New "DL0600-400/125," specifically designed for use in precision analog computing, auto-correlation, and subsonic and sonic applications, features extremely long delay (which may be extended further by cascading several units), low attenuation, and excellent phase linearity over a wide range of frequencies. Its 125 taps are brought out on front panel by heavy double turret lugs. Over-all delay 5000 usec; characteristic impedance 600 ohms; LF insertion loss 1.7 db; cutoff frequency 9.5 kc, phase linearity 0.2% up to 6 kc.—*Epsco, Inc.*, 588 *Commonwealth Ave.*, *Boston* 15, *Mass.*

For more information circle **288** on inquiry card.

WIRE-WOUND VDRs

Two new units in maker's "AP-½" line of miniature precision voltage-dividing resistors are 50-k and 100-k values. Both embody basic design features of earlier units: 2-watt rating at 80°C, all connections spot-welded or soldered, gold-plated fork-type terminals, servo or bushing mount, anodized aluminum body, and centerless-ground stainless-steel-alloy shaft. —*Waters Mfg., Inc., P. O. Box* 368, *South Sudbury, Mass.*

For more information circle **289** on inquiry card.

HIGH-TEMPERATURE VDR

New "RVG-14" metal-housed, ⅞"-dia ¾-oz voltage-dividing resistor is said to feature "dependable performance, particularly where severe vibrations and high operating temperatures are encountered." It is available in single as well as multi-gang construction, with sleeve or ball bearings. Winding resistances from 25 to 45,000 ohms; minimal resolution of 0.06% and optimal linearity of 0.25% where specified. Max continuous operating temperature is 150°C (302°F).—*The Gamewell Company, Newton Upper Falls* 64, *Mass.*

For more information circle **290** on inquiry card.

PISTON CAPACITOR

New sub-miniature piston capacitors were designed primarily for use in graphic circuitry and automation. Two models, "VC9G" and "VC10G," both feature glass dielectrics; silver-plated Invar rotors; temperature −55°C to 125°C; dielectric strength greater than 1000 vdc.—*JFD Mfg. Co., Inc.,* 6101-16*th Ave., Brooklyn* 4, *N. Y.*

For more information circle **291** on inquiry card.

MINIATURE ELECTROLYTICS

New "Ultra-Miniature Electrolytic Capacitors" are now available in forty-two types. Capacitance range

from 0.15 to 160 uf; voltage ratings from 1.5 to 70 vdcw; diameters from ⅛" to 23/64"; operating temperature range −30° C to 60° C. All units hermetically sealed; are said to be "the smallest aluminum foil electrolytics available anywhere."—*Dep't. RW., Barco, Inc., Box* 1222, *Milwaukee* 1, *Wisconsin.*

For more information circle **292** on inquiry card.

"ONE-END" CAPACITORS

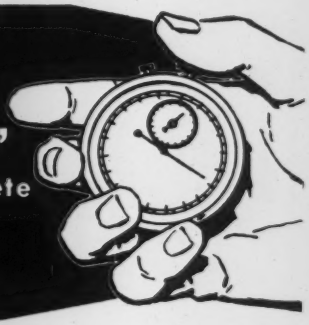
New "Perm-A-Cap" capacitors, for automatized insertion into graphic circuit boards, feature Bakelite housings carefully molded to precise tolerances; withstand high temperatures,

now...

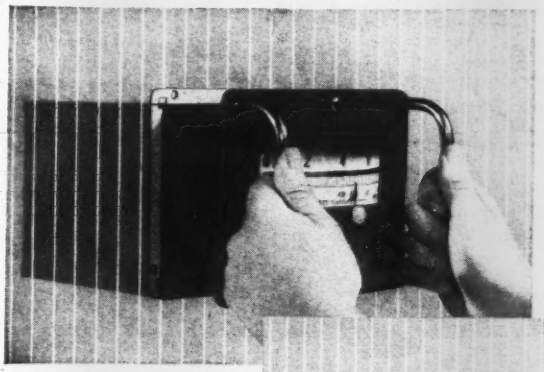
THE TRUE "PLUG-IN"

seconds to exchange complete temperature control units

by **WEST**

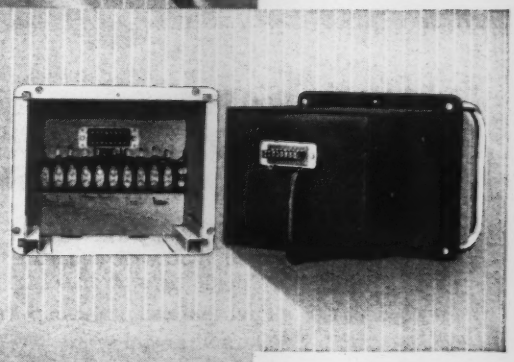


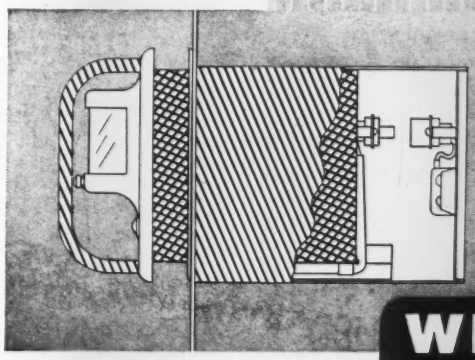
Ideal for modern *continuous* operations; *Perfect* for round the clock shift *maintenance. Eliminates down time!* Available for all types of West Instruments—On-Off, Stepless, Proportioning, etc. New, or supplied as modification kit for instruments in use.



No tools needed; no control loss

Built-in plug, automatic alignment





May be flush or surface mounted

★ Write for Bulletin Q

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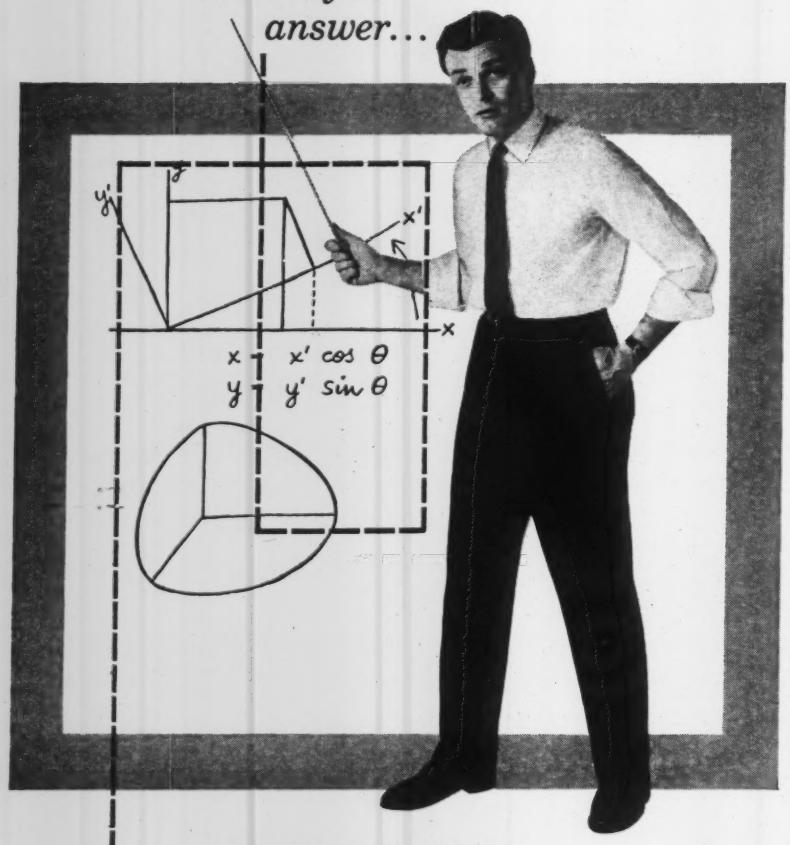
For more information circle **96** on inquiry card.

Here's your answer...



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Norden-Ketay high-quality resolvers provide you with accurate solutions to problems encountered in:

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- Data Transmission
- Industrial process controls
- Rectangular to polar coordinate transformations
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These precision resolvers are available to standard sizes (10, 11, 15 or 23) or may be ordered to your specifications.

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For more information circle **97** on inquiry card.

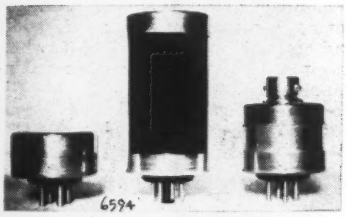
NEW INSTRUMENTS

shock, vibration and handling; contain no outer wax that can drip off onto chassis.—*Chicago Condenser Corp., 3255 W. Armitage Ave., Chicago 77, Ill.*

For more information circle **293** on inquiry card.

PLUG-IN UNITS

New plug-in units made of heavy gage (0.060") aluminum are available in stock lengths from 1" to 12" in



steps of ½"; standard OD 1-⅞"; are applicable to special requirements including potting.—*Stamco Instrument Co., Larkin St., Springdale, Conn.*

For more information circle **294** on inquiry card.

ELECTRONIC COMPONENTS

NEON THYRATRONS

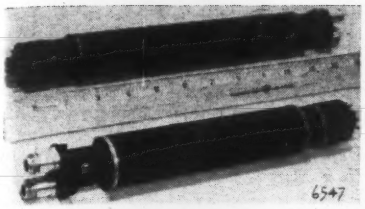
New 6.4-amp. xenon thyratrons for use with any type of load without the addition of "cushion circuits" are un-

affected by ambient temperature changes and can be operated in any position; are available with (1) new lug-type base, (2) socketless bracket mounting having flexible leads with lugs, (3) standard 4-pin industrial socket base.—*Electrons, Inc. 127 Sussex Ave., Newark, N. J.*

For more information circle **295** on inquiry card.

METAL T-W TUBES

Two new traveling wave tubes, for use as wide-band amplifiers in microwave, radar and countermeasures

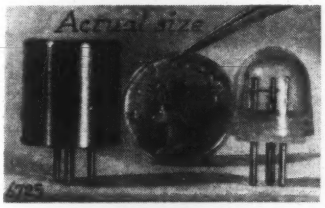


equipment, have metal envelopes for maximal ruggedness. "F-6658" is for 1 watt cw or 5 watts pulse operation at S-band frequencies from 2,000 to 4,000 Mc with minimum gain of 30 db. "F-6825" pulse tube, 1 kw output with 20 db minimum gain in S-band from 3,400 to 3,600 Mc.—*Components Div., Federal Telephone and Radio Co.*, 100 Kingsland Road, Clifton, N. J.

For more information circle **296** on inquiry card.

500-MC TRANSISTORS

New silicon (left) and germanium (right) transistors are said to represent "a major breakthrough in tran-



sistor technology . . . an entirely new kind of transistor"; are produced by radically new diffused-junctions process; have frequency cut-off between 500 and 600 Mc, as against 1 to 10 Mc for older transistors and 100-200 Mc for some new special transistors. —*Bell Telephone Laboratories*, 463 *West St., New York* 14, *N. Y.*

For more information circle **297** on inquiry card.

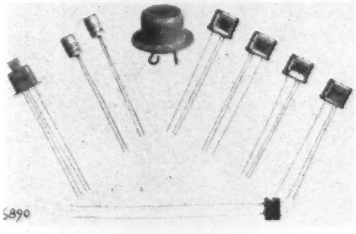
POWER SILICON TRIODE

New "ZJ 16" *p-n-p* alloy junction silicon transistor, is capable of dissipating 8 watts at 85°C and 4 watts at 120°C. Maximum collector voltage is rated 75; alpha cutoff 100 k.c. Among applications: servomechanims, switching, etc.—*General Electric Co., Electronics Park, Syracuse, N.Y.*

For more information circle **298** on inquiry card.

SEMICONDUCTOR PRODUCTS

Newly available: three point-contact switching transistors, one grown-junction triode transistor, an alloy-junction power transistor, a grown-junction tetrode transistor, a phototransistor and two silicon varistors, pre-



a big plus for precision laboratory testing

model 160 Broadband Amplifier

- Amplifies low-level counter pulses
- Increases sensitivity of oscilloscopes and voltmeters
- Facilitates ultrasonic delay line measurements
- Drives high-speed electronic counters
- Used as post amplifier in noise measurements.

The versatile Model 160 Broadband Amplifier is the ideal instrument for general laboratory use. Frequency response is 15 kc to 50 mc at 3 db points, with a maximum gain of 60 db into a 1000 ohm load. Gain is continuously variable over a 20 db range from 40 db to full gain. Maximum output is 18 volts peak to peak. Rise time is less than 0.010 microseconds. Restrictions on gain and bandwidth are minimized through the use of distributed amplifiers. Designed for mounting in a standard rack.

The Model 160 is one of a new line of New London instruments for precision testing. Write for complete information.

NEW LONDON INSTRUMENT Company INC.

32 UNION ST., NEW LONDON 15, CONN.

For more information circle **98** on inquiry card.

PRECISION

defined by the dictionary

...."the quality or state of being precise; accuracy; mechanical exactness."

defined by an instrument maker . . .

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- exact tolerances
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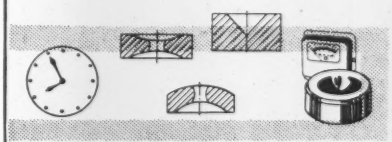

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  Platinum Content provides unsurpassed resistance to corrosion . . . long shelf life.
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For more information circle **100** on inquiry card.

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Pushbutton choice of 12 speeds while operating

Top panel zero adjustments

Complete remote control

Timing line interval set automatically by chart speed

The S-25 Oscillograph

The S-25 has many exclusive features that make it unusually convenient to operate in a wide variety of recording applications. Write for additional information on the S-25, then compare its unequaled features with those of any other oscillograph.

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For more information circle **101** on inquiry card.

NEW INSTRUMENTS

viously made only for U. S. Army Signal Corps) may now be obtained directly from maker for military applications.—*Western Electric Co., Radio Div., Electronics Products Dept.*, 120 *Broadway, New York* 5, *N. Y.*

For more information circle **299** on inquiry card.

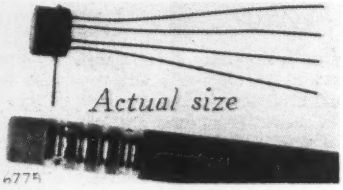
SUBMINIATURE DIODES

New subminiature germanium diodes, hermetically sealed and cased in glass, are said to "have electrical properties far superior to those of older types"; are available in most standard types and also in a series of special high-conduction ("DR") types. Some "DR" series can handle an operating voltage of 150, can deliver a minimum of 400 milliamperes at plus 1 volt, with reverse leakages as low as 20 microamperes maximum at −100 volts.—*Radio Receptor Co., Inc.*, 251 *W. 19th St., New York* 11, *N. Y.*

For more information circle **300** on inquiry card.

SIGNAL TRANSISTOR PACKAGE

New signal transistor package (sponsored by US Air Force) has lead arrangement such that package will

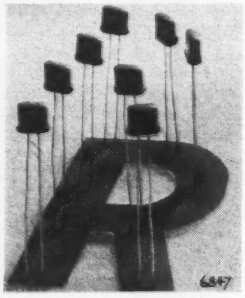


plug directly into graphic wiring boards or transistor sockets without forming of leads. Thus it is suitable for automation. Tab protruding from cap furnishes both indexing and a means of grounding device for shielding purposes.—*General Electric Co., Electronics Park, Syracuse, N.Y.*

For more information circle **301** on inquiry card.

BONDED SILICON DIODES

Eight new bonded silicon diodes have inverse voltage ratings from 15 to 225 v; are similar to units not designated "A" but have higher forward current ratings with no increase in reverse current; operate at ambient temperatures from −55°C to 150°C with excellent stability and low re-



verse current. Volume is about 0.009 cu in. Every diode receives four temperature cycles of 1 hr at −55°C and 1 hr at 150°C, following by 36 hr at 95% relative humidity and 70°C. Exact characteristics are maintained.—*Raytheon Mfg. Co., 55 Chapel St., Newton 58, Mass.*

For more information circle **302** on inquiry card.

HF SILICON BONDED DIODES

New silicon diodes, being produced in a subminiature glass case, exhibit excellent high-frequency and fast-

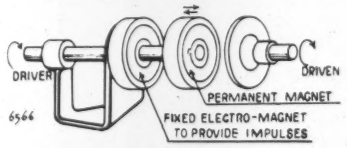
switching characteristics; are intended for use in detector, discriminator or pulse circuits where high-temperature performance is important; feature low shunt capacitance (0.8 uufd average), high inverse resistance and moderate forward conductance, electrical and mechanical ruggedness.—*Transitron Electronic Corp., Melrose 76, Mass.*

For more information circle **303** on inquiry card.

ELECTROMECHANICAL COMPONENTS

PERMANENT-MAGNET CLUTCH

New type of magnetic clutch requires no electric current for its operation except for an impulse for en-



gaging or disengaging; was originally designed for tape recorders but will find applications in servo-mechanism, automotive and air conditioning fields. —*Locke Machine Co., 971 E. 63rd St., Cleveland 3, Ohio.*

For more information circle **304** on inquiry card.

HERMETIC HEAD SEALERS

New compression-sealed "Amphenol" hermetic seal headers are available in ten different types with four different contact styles and numerous contact layouts for each. Color of glass in Amphenol Headers is a distinctive brown for easier product recognition.—*American Phenolic Corp., Chicago 50, Illinois.*

For more information circle **305** on inquiry card.

SIZE 23 SYNCHRO

New "Type 3J-4222" size 23 60-cps synchro torque transmitter-receiver is "ruggedized": meets shock and vibra-

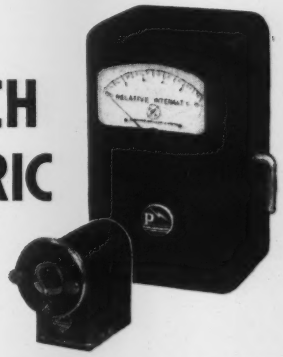
WITHOUT EQUAL

in fast, flexible, accurate control of

HIGH TEMPERATURES

New

PHOTOSWITCH PHOTOELECTRIC PYROMETER



The Photoswitch Photoelectric Pyrometer is a *precision instrument* with all the speed, flexibility, and ruggedness of a *production tool.*

■ **AT A DISTANCE,** the hot object is scanned by a special phototube whose electrical output is proportional to the temperature. There are no delicate connecting wires, no junctions to burn out.

■ **CONTINUOUS TEMPERATURE INDICATION** is shown on a meter, with no perceptible lag. Total range of the instrument is from 1000° to 5000°F. Operating ranges can be selected by varying the calibrated opening of the scanner lens assembly.

■ **CONSTANT ACCURACY** results from a *selective* response to infrared radiation that substantially reduces interference caused by oxides or scale on the hot object, or vapor and smoke in the scanner's field of view.

■ **AUTOMATIC CONTROL** of temperature is provided through a heavy-duty relay in the control unit, actuated when the temperature changes by as little as 5° from any pre-set point. Through the relay, the primary heat supply — or any desired process step — can be governed.

■ **RUGGED, TROUBLE-FREE SERVICE** has been proved in many applications. Typical are induction heating, metal forming, flame hardening, continuous brazing.

Photoswitch DIVISION

ELECTRONICS CORPORATION OF AMERICA

Dept. P32-4, 77 Broadway • Cambridge 42, Massachusetts

WRITE FOR BULLETIN PT 556

For more information circle **102** on inquiry card.

Cut Your Gauging Costs

with the "Varec" Fig. No. 2500 AUTOMATIC TANK GAUGE

View of the new Watson terminal of the Southern Pacific Pacific Pipe Line. "Varec" Fig. 2500 Series Gauges are used on the entire line from El Paso to Watson.

After two years of research, development and testing at the plant and in the field in several types of service, the first "Varec" Figure No. 2500 Automatic Tank Gauge was sold in February 1952.

Since that time several improvements have been made. Now there are over 4000 of these Gauges in all kinds of service throughout the world.

This phenomenal volume resulted because the "Varec" Figure No. 2500 *first* introduced the Neg'ator Motor to the Petroleum Industry. The Neg'ator Motor is a novel spring mechanism that is stressed sequentially by increments and NOT by winding, in contrast to the conventional spring. It is a self-winding spring and maintains constant tension throughout float travel. It eliminated calibrated tapes, counter-weights and slip joints, thus providing easy installation.

Another revolutionary feature is the direct reading counter-dial, with large distinct numerals close to the look-box face. This unit is carefully sealed off from the vapors, grease and dirt that plague tape-reading gauges to assure a clean, accurate reading in feet, inches and eighths, or inches and tenths, or the metric system.

All the parts incorporate materials and workmanship of the highest quality and are designed for long life, maximum service and minimum maintenance. Type 316 stainless steel ball bearings throughout. Housing is aluminum and all other parts are either aluminum or type 316 stainless steel. No plastic parts to warp, deteriorate or collect static electricity.

Provides for attachment of remote transmission systems or high-low control switches (either electric or pneumatic). Unnecessary to remove tape for punching, or to buy a new tape. Remoting equipment mounted outside Gauge Head without dismantling the Gauge Assembly.

Serves all types of tanks up to 66 feet in height and pressures to 300 p.s.i.g.

For full information write the factory or contact your nearest "Varec" representative.

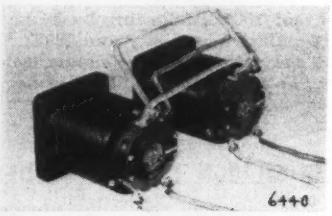
Varec

THE VAPOR RECOVERY SYSTEMS COMPANY
Compton, California, U. S. A.

Cable Address:
Varec Compton California (U.S.A.)
All Codes

961-13

For more information circle **103** on inquiry card.



tion tests of BuShips Spec 40T9; withstands 2000-hr operating life test at 1200 rpm; meets humidity specs of BuShips 16E4. Electrical accuracy of two-unit system is 1°. Weight per unit under 1.5 lbs.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **306** on inquiry card.

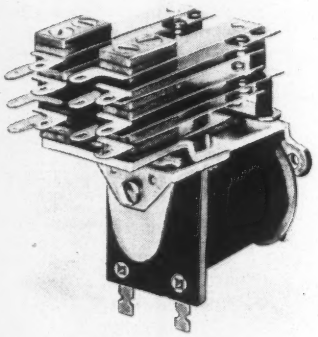
MINIATURE PHONE-TYPE RELAY

New "7MS" miniature telephone relay, designed for motor control, mobile radio, etc., has a life of 100,000 operations minimum under a 5-amp 125-vac contact load (more under lesser load); is fast-acting (less than 0.01 sec); 100 milliwatt minimum operating power; maximum coil dissipation 1.5 watts; meets MIL-R-5757B Class A. —*Kurman Electric Co., Inc., 35-18 37th St., Long Island City, N. Y.*

For more information circle **307** on inquiry card.

ALL-PURPOSE RELAY

New "Amrecon Model CRU" relay features wide range of available contact combinations. Standard rating



5 amp @ 115 vac or 32 vdc noninductive load.—*Ohmite Mfg. Co., 3683 Howard St., Skokie, Ill.*

For more information circle **308** on inquiry card.

ETCHED-CIRCUIT TEST JACK

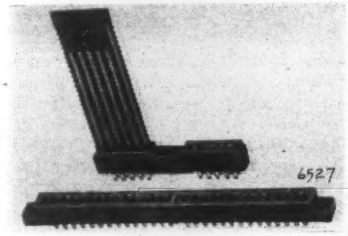
New test jack enables etched and printed circuit engineers to solve test print and monitoring problems. Jack is ¼" OD and about ¼" high; rivets to the board like an eyelet. Vari-

colored phenolic snap-on insulating sleeves protect fingers and provide color-coding for test points.—*Grayhill, 561 Hillgrove Ave., La Grange, Illinois.*

For more information circle **309** on inquiry card.

GRAPHIC CIRCUIT RECEPTACLE

New "PCSC28" 28-contact graphic circuit receptacle has a center barrier as part of molding to provide extra



strength and prevent warpage. Gold plated phosphor bronze contacts are available in single or double rows to accommodate up to 56 connections. —*DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **310** on inquiry card.

SIZE 11 SERVO GEAR TRAIN

New "Type 3LR-3265" size 11 servo-gear-train weighs 6.875 oz; consists of a single unit instead of two sepa-

rate parts; can be built to operate at 150°C ambient. Versatility: motor can be made to operate as a 2; 4; 6- or 8-pole motor; windings can be made to operate on 60 or 400 cps, 26 to 115 v. Gear ratios from 12:1 to 4000:1. A slip clutch is available if desired.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **311** on inquiry card.

MECHANICAL COMPONENTS

HYDRAULIC HOSE FITTING

New "no-skive Hoze-lok" re-usable fitting meets demand for easier make-up of hydraulic hose assemblies incorporating rubber-covered wire-braid hose; consists of socket and nipple; does not require hose cover to be stripped off. Make-up is accomplished in two simple steps: (1) hose is rotated into socket counter-clockwise, and (2) nipple is screwed clockwise into hose and socket. Lead thread of

Take a

QUICK LOOK

at your data with a

POTTER DIGITAL RECORDER

You can "look into" your digital data-processing equipment conveniently and with complete assurance of accuracy, using a Potter Model 960 Digital Recorder. Permanent, easily-stored records, capable of quick visual interpretation, may be made of electrical phenomena without interrupting the operation of equipment being monitored.

SPECIFICATIONS:

NO. OF CHANNELS Up to 32 on standard models; more on special order

RECORDING SPEEDS 150 measurements per second—continuous; up to 10 per second-intermittent

CHANNEL SENSITIVITY —25 volts—print; 0 volts—no print

RECORDING MEDIUM "Teledeltos" sensitized paper; standard 400-foot roll provides up to 52,000 measurements

PAPER TRAVEL Adjustable from front panel, 2½" to 20" per second; continuous or intermittent

Potter Digital Recorders are being used daily to monitor computer operation, digital data-processing equipment and other applications. With minor modifications, standard recorders can be provided with different input voltages, higher recording speeds and more channels. Write today describing your "quick look" data recording requirements. Let our engineers suggest an appropriate solution; no obligation, of course.

Potter **POTTER INSTRUMENT COMPANY, INC.**

115 Cutter Mill Road, Great Neck, N. Y.

For more information circle **104** on inquiry card.

INSTROF

Continuous Support and Protection for Instrument Tubing

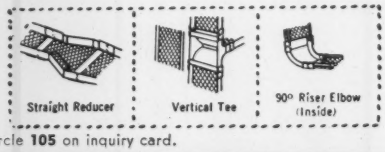
Tubing may readily be run to individual instruments or panels as needed.

Delicate instruments quickly become useless without adequate tubing support. Instrof provides a flexible, simple-to-install system for maximum efficiency and dependability at minimum cost. Famous Pin-Type Coupling available for wide range of standard fittings and runs.

Instrof is a system of Prefabricated Expanded Metal Trough specifically designed for rigid, continuous support and protection of instrument tubing. All parts are hot-dip galvanized for long life. Widths of 3", 6", 9", 12", 18", and 24", lengths of 8', 10', and 12', and a complete line of fittings allow the Instrof system to meet the demands of virtually any plant layout.

Exclusive Pin-Type Coupling speeds installation and reduces labor costs. Just two coupler pins and a bottom plate are needed to complete a connection.

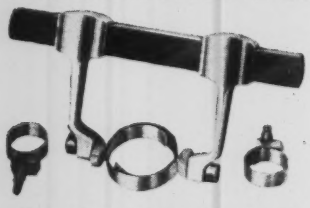
INSTROF CORP.
DIVISION T. J. COPE, INC.
COLLEGEVILLE 21, PENNA.



For more information circle **105** on inquiry card.

THE ROLYN *(Snake) Plier*

An indispensable tool for assembly and dismantling of optical, radio, scientific instruments and all kinds of mechanical equipment.



The SNAKE PLIER consists of two coil springs with their turns interleaved, attached to two arms projecting from and sliding for adjustment of diameter on the main supporting bar. Two sets of springs are supplied and additional sizes are available.

Ideal for use in all fields where a positive friction grip is required in loosening, or tightening, of the most delicate and fragile threads, or thin wall tubing without danger of damaging, or of marking. Can be used on right or left hand threads. It is equally effective at any angle.

Exhaustive tests in Government workshops and research depts. have proved the efficiency of the Rolyn SNAKE PLIER.

PRICE POSTPAID **$28.60**

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Address Reply to Post Office Box 745, Arcadia, California

For more information circle **106** on inquiry card.

VOICE COMMUNICATION PLUS Control

RFL Model 983
OPERATES OVER WIRE CIRCUIT OR MICROWAVE

•

2-Way Clear Voice and Reliable Control

•

Frequency-Shift Fail-Safe Operation

•

Voicon®
VOICE plus CONTROL Terminal

Provides two, reliable frequency shift control channels at 2800 & 3000 cps isolated from voice by filters. Isolation transformers allow connection to balanced wire circuits. Interchangeable plug-in components and printed circuit boards are used in transmitter, receiver and power supply sections.

The VOICON is one of many RFL terminal units for control, telemetering, teletype, voice or data transmission.

Write for Technical and Application Data.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **107** on inquiry card.

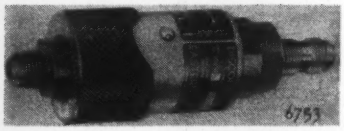
NEW INSTRUMENTS

socket, acting like the colter wheel on a plow, cuts through rubber cover hose, permitting following threads to contact wire braid.—*Parker Appliances Co.*, 17325 *Euclid Ave., Cleveland* 12, *Ohio.*

For more information circle **312** on inquiry card.

PNEUMATIC DISCONNECT

New double self-sealing, straight-through disconnect instantaneously converts any pneumatic connection

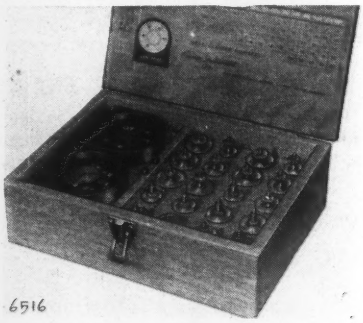


into a straight-through line. When disconnected, checked end serves as a bubble-tight leak-proof shut-off valve. One-quarter turn by hand connects or disconnects under pressure up to 3,000 psi.—*Eastern Aircraft Products Corp.*, 229 *River St., Orange, N. J.*

For more information circle **313** on inquiry card.

UNIVERSAL GEAR TRAIN

New "107U" kit provides 20 common laboratory ratios from 20:1 to 1600:1, consists of a universal hous-

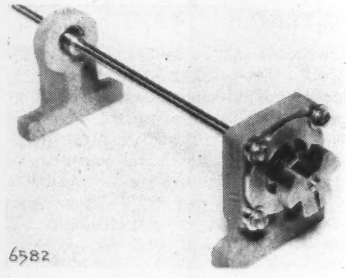


ing made of anodized aluminum and 20 stainless steel gear clusters, packaged in a dust-proof box; effects large savings in breadboarding space; does away with difficult alignment and backlash problems.—*Bowmar Instrument Corp.*, 2425 *Pennsylvania St., Fort Wayne, Indiana.*

For more information circle **314** on inquiry card.

LIMIT STOP ASSEMBLY

New "Type #X2," immediately available from stock, comprise a series of precision lug washers each of

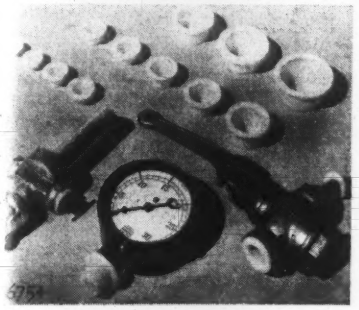


which comes in contact with an adjacent washer or with frame stops. Number of turns of limit stop shaft is determined by number of washers used and by setting of adjustable limit stop ring. Rotational limits from 30° to 4,530°.—*PIC Design Corp.*, 160 *Atlantic Ave., Lynbrook, L. I., N .Y.*

For more information circle **315** on inquiry card.

THREAD PROTECTOR CAPS

New resilient caps molded of Tenite polyethylene protect threaded parts and against dust, dirt and dam-



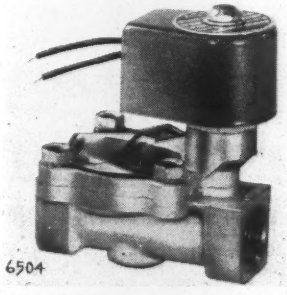
age; serve either as caps over external threads or as plugs to protect internal threads, during assembly, shipment or storage; are made in green or yellow colors; come in sizes and styles to fit all threads and openings.—Tenite is made by *Eastman Chemical Products, Inc., Kingsport, Tenn.* Caps are produced by *Clover Industries, Inc.*, 528 *Young St., Tonawanda, N. Y.*

For more information circle **316** on inquiry card.

VALVES

SHUT-OFF SOLENOID VALVE

New "Bulletin 8210A" ¾" general-purpose 2-way solenoid valve with full-area port is internal-pilot-oper-



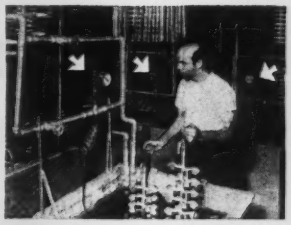
ated. Available n-c, opens when solenoid is energized; or n-o, opens when solenoid is de-energized.—*Automatic Switch Co.*, 391 *Lakeside Ave., Orange, N. J.*

For more information circle **317** on inquiry card.

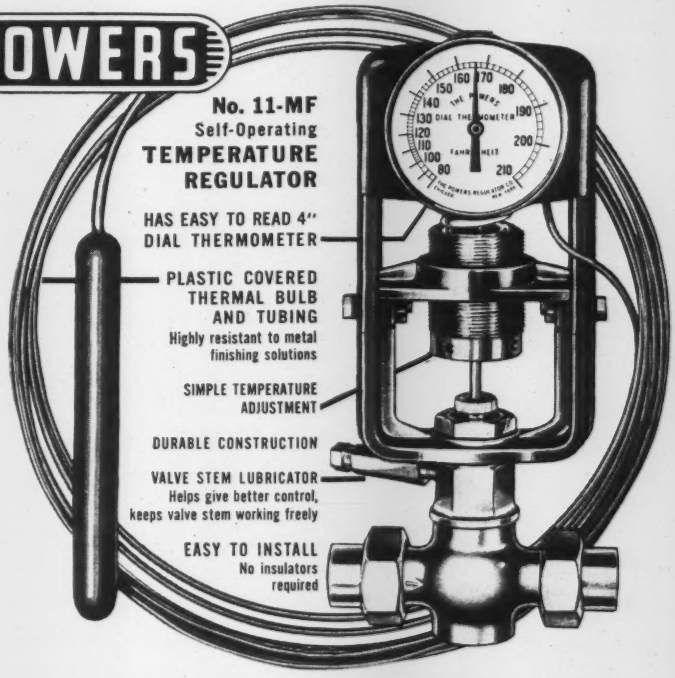
BUTTERFLY VALVES

New "Lug Type" valves feature threaded bolt holes (instead of drilled holes ordinarily supplied on valves designed for use between flanges) so

For Plating, Cleaning and Rinse Tanks



POWERS



Simplest, Most Reliable Control Made
Holds Temperature at the Right Point
Savings Often Repay Its Cost 3 to 6 Times a Year

Why Powers No. 11-MF Regulator Gives Better Control and Lasts Longer—better TEMPERATURE Control results from powerful bellows and minimum of valve stem friction. Valve Stem Lubricator aids easy movement of valve stem without binding. Double ply metal used in Powers bellows outlasts ordinary single ply type. Greater durability of plastic covered bulb and tubing also helps prolong the life of the regulator.

Dial Thermometer indicates temperature of solution under control. It gives a visual check of the process and makes it easy to adjust regulator for different temperatures.

Eliminate "the human element" in temperature control with Powers automatic Regulators. They're simple, compact and dependable. They stop OVER-heating, prevent "boil-overs," waste of steam, water wasted by evaporation, burnt plated parts, rejects, decomposition of costly additives and loss of volatile ingredients from cleaning solutions.

Powers Nationwide Service and 24 Hour Delivery in the U.S.A. are important time and money saving advantages. Order a Powers No. 11-MF Regulator now. Call your supply firm or write us direct for Bulletin 330 and prices. (c43)

POWERS CONTROL

THE POWERS REGULATOR COMPANY

SKOKIE, ILLINOIS | *Offices in chief cities in U.S.A., Canada and Mexico*

Over 60 years of Automatic Temperature and Humidity Control

For more information circle **103** on inquiry card.

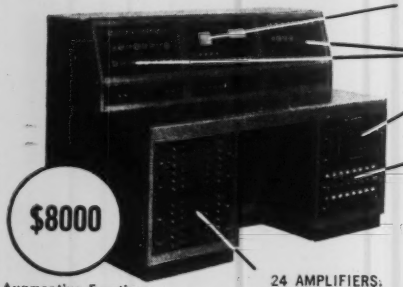
more performance at less cost

Solve for: Lift component 'L' of a total aerodynamic force at +90° with respect to velocity direction of an aircraft.

$$L(v,\gamma,\delta_1,\frac{d\phi}{dt},\rho)=\left(L(v_1,\gamma_1,\delta_1,o,\rho)+L_{\cdot}\bar{V}+L_{\gamma}\bar{\gamma}+L_{\delta 1}\bar{\delta}_1+\delta\phi\frac{d\bar{\phi}}{dt}\right)\left(-R_o\sum_{i=1}^{n}\frac{X_i}{R_i}\;\frac{(-A)}{(1-A)+R_o\sum_{i=1}^{n}\frac{1}{R_i}}\right)$$

Difficult problems—even twelfth-order linear differential equations and nonlinear equations—are no problem for the **WEBER GENERAL PURPOSE ANALOG COMPUTER.** It requires no auxiliary equipment to present dynamic solutions in acoustics, aerodynamics, vibration, thermodynamics, structures, and chemistry. As a **simulator,** the unit can be used to find operation parameters; to study missile trajectory and various aerodynamic factors of yaw, pitch, and roll.

We think it's the greatest thing since the Model T, and if you don't believe you can get all of this for $8000, give us a chance to prove it to you. Write for more information.



DUAL OPERATIVE TIME, real and fast, with instantaneous switching and 5" dual beam scope.

36 POTENTIOMETERS

SIMPLIFIED EQUATION BOARD eliminates programming of problem.

FUNCTION GENERATOR included as standard equipment.

CABINET DESIGN provides sliding racks for individual component housing.

$8000

Augmentive Functions Available

24 AMPLIFIERS: 12 integrating/summation; 12 summation.

Weber ELECTRONICS

A division of Weber Aircraft, 2820 Ontario Street, Burbank, California

For more information circle **109** on inquiry card.

RAWSON METERS

MULTIMETERS and REGULAR METERS
AC and DC types, multiple ranges, accuracy — ½ of 1%. 2 microamperes to 1 ampere DC. 2 milliamperes to 3 amperes AC.

ELECTROSTATIC VOLTMETERS.
Ranges 100 V to 35,000 V, AC or DC. Resistance exceeds million megohms. Can measure static electricity.

FLUXMETERS
Laboratory and production measurements on magnets and magnetic circuits. Single push button return-to-zero.

ROTATING COIL GAUSSMETERS
Our most recent development for measuring magnetic field strengths. Measures from a few gausses to 120 kilogausses.

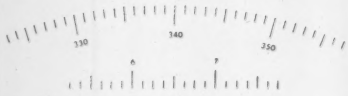
SINE-COSINE POTENTIOMETERS
Now available, popular type RL11C, for radar and computor circuits — *write for new bulletin.*

Rawson ELECTRICAL INSTRUMENT CO.
112 POTTER STREET, CAMBRIDGE, MASS.

For more information circle **110** on inquiry card.

MACHINE-DIVIDED SCALES

Made with latest SIP Swiss Automatic Dividing Machines



LINEAR
Accuracy to ±5 microns (0.0002")

CIRCULAR
Accuracy to ±5 seconds
Any scale pattern—Any line width—Any material

FINE MACHINE ENGRAVING
Scales, Dials, Drums, Rods, Panels

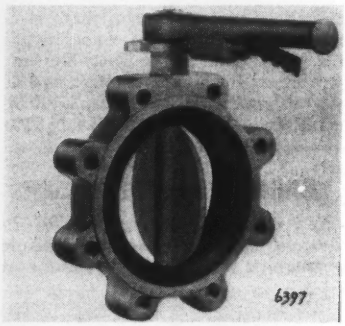
ACCURATELY ETCHED RETICLES
Made to any specified pattern and dimensions

PROMPT DELIVERY
on large or small quantities.

L. C. RENICK CO.
3820 So. 59th Court, Cicero 50, Illinois

For more information circle **111** on inquiry card.

NEW INSTRUMENTS

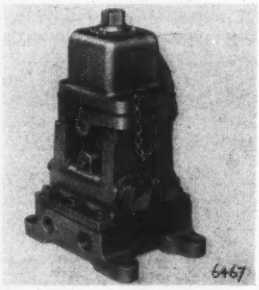


that with valve closed, flange on either side of valve can be disconnected with full pressure held on opposite side. No need to "bleed down" entire line. Sizes from 2" to 12", for use between standard ASA 125-psi or 150-psi flanges, as specified.—*Keystone Tool Corp., P.O. Box* 6716, *Houston, Texas.*

For more information circle **318** on inquiry card.

VALVE SOLENOID AND COVER

New solenoid and cover assembly, built to JIC standards, can be applied to 3-way and 4-way types and to sizes



from ¼" through 1¼"; can be manually operated without removing cover and becomes electrically inoperative when cover is removed; is interchangeable with maker's standard cover and solenoid units.—*Ross Operating Valve Co.,* 120 *E. Golden Gate Ave., Detroit* 3, *Mich.*

For more information circle **319** on inquiry card.

MISCELLANEOUS

ALERTNESS INDICATOR

New "Model 48-P2," for use in determination of state of alertness of human beings, amplifies certain bio-

electric potentials which have been found, in researches at Tufts University, to be affected by alertness. Amplified signal is rectified and fed to an indicator on front panel; can also be fed to a suitable recorder. Signal from amplifier before rectification is also available for viewing on a CRO. Among other features: (1) relay operates when output falls below a given level, sounds an alarm or actuates some other device; gain control located between second and third amplifier stages, thus affecting indicator, recorder, CRO, and relay operation simultaneously.—*Berkshire Labs*, 682 *Hank Village, Greenville, N. H.*

For more information circle **320** on inquiry card.

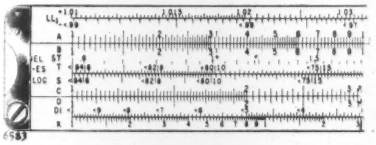
DRAWING MATERIAL

New "Mylar," said to be "the most stable drawing material known," is now available with grid lines that are not photographically reproducible and therefore will not show up on the negative or glass-work made from multi-size master black-and-white printed circuit drawing. Grid pattern was especially designed to take advantage of the basic 1/10" pattern of the "automated" R.C.A. Programmed Punching Machine for printed circuit boards.—*Photocircuits Corp., Glen Cove, N. Y.*

For more information circle **321** on inquiry card.

EYE-SAVER SLIDE RULES

New slide rules are green-yellow, eliminating violet and red rays which focus in front of and behind retina.



Their green-yellow shade coincides with optimal sight point of spectrum, cuts eyestrain, blurring and errors in reading calibrations. Non-corrosible non-rusting alloy: no warping or binding. Available in 6" and 10" Trig, Log-Log standard rules, or to special order.—*Pickett & Eckel, Inc.*, 1109 *South Fremont Ave., Alhambra, Calif.*

For more information circle **322** on inquiry card.

DRAFTING MACHINE

New "Desk-Topper" is said to be "the world's first complete, portable drafting system of professional qual-

Shallcross

for **precision resistors**

SINCE 1929

AKRA-OHM Precision Wirewounds

Bulletin L-35

High-quality, yet moderately-priced precision resistors suitable for the majority of applications. Reverse-pi wound on accurately-machined ceramic bobbins. Coated, if desired, with moisture-resistant varnish. Std. tolerance—1%, 0.5%, 0.25%, 0.1%, and 0.05%. Meets MIL-R-93A. Five mounting styles available.

"P" TYPE Encapsulated Wirewounds

Bulletin L-30

Small, hermetically-sealed resistors at a truly low price. Unmatched stability for critical applications. Std. tolerance—same as Akra-Ohm types above. Meet and exceed MIL-R-93A requirements including salt water immersion tests. Radial leads, axial leads, or lug type terminals.

CASTOHM® Ceramic Power Resistors

Bulletin L-29

Unusually light-weight wirewound power resistors with a unique integral core and coating having exceptional resistance to thermal shock and excellent heat conductivity. Ten humidity-resistant, tab-terminal styles available with ratings from 8 to 225 watts at 350°C. hot-spot. Meet MIL-R-10566, Amendment 1.

CMP and **MP** Miniature Power Wirewounds

Bulletin L-36

Lead-mounting, miniature power wirewounds for crowded chassis or printed circuits. MP types enclosed in a Fiberglas sleeve and coated with silicone-impregnated ceramic. CMP types encased in ceramic tube with ends hermetically sealed with silicone cement. Designed to MIL-R-26B. 3 to 10 watt sizes available.

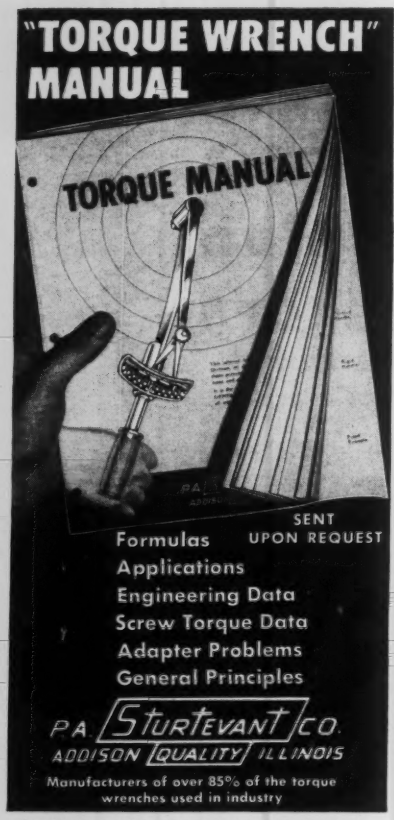
SPECIALS . . . . . .

Bulletin L-37

Hermetically-sealed Steatite resistors, Ayrton-Perry resistors, high-voltage surge resistors, card-type resistors, multi-section bobbin resistors, and many other special types are regularly produced to individual specifications.

SHALLCROSS MANUFACTURING COMPANY, 510 Pusey Ave., Collingdale, Pa.

For more information circle **112** on inquiry card.

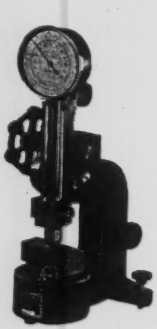


For more information circle **113** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 50 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.



Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway Jamaica 35, N. Y.

For more information circle **114** on inquiry card.

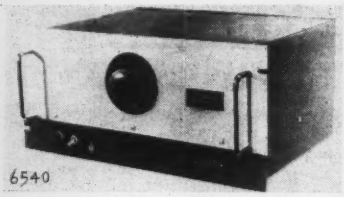
NEW INSTRUMENTS

ity, yet designed and priced for personal use." It comprises a personal-size professional drafting machine complete with folding drawing board, metal scales, instrument box and carrying carton or travel case.—*The Universal Drafting Machine Corp.*, 7960 *Lorain Ave., Cleveland 2, Ohio.*

For more information circle **323** on inquiry card.

AC VOLTAGE REGULATOR

New "Model E-80," commercially-available "package" of a system previously used in maker's precision pro-

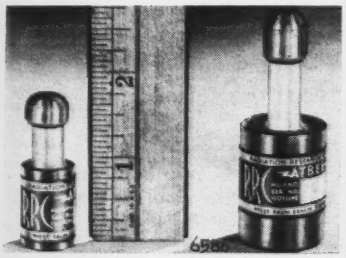


duction testing equipment and automatic machines, is said to have "two major features superior to other types": (1) it suppresses line harmonic distortion, maintaining a sine wave even under extreme half-wave loading, and (2) it has a response time of about 0.001 sec with no thermal or magnetic-circuit lag. Models are available with fixed 115-v output, or variable from 50 to 125 v; 60 or 400 cps.—*El Mec Labs, Inc.*, 730 *Boulevard, Kenilworth, N. J.*

For more information circle **324** on inquiry card.

NUCLEAR-ENERGY CELL

New "Atbee" 17,000-v single-cell "atomic" battery is smaller than a 1½-volt flashlight battery. It con-

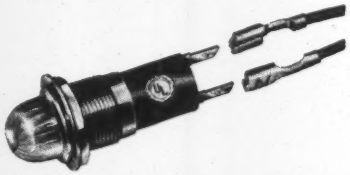


verts nuclear energy directly into electricity through a specially-developed solid dielectric. It is said to make "an ideal power source for dosimeter chargers, timing circuits, trickle chargers, Geiger counters, electrostatic generators, scintillation counters and ionization counters." It delivers 17,000 v per cell with a maximum current of one millimicroampere; has a 25-year half-life, can be used in temperatures from —65 to 65°C. Currently-available "Models F-10 and F-50" contain, respectively, a 2-mc and a 10-mc strontium-90 source.—*Radiation Research Corp.*, 140 *E. 59th St., New York, N. Y.*

For more information circle **325** on inquiry card.

QUICK-CONNECT PILOT LIGHTS

New indicator lights, which accommodate bayonet type miniature lamps, are available with spade terminals:



matching male parts for convenient "quick-connect" type wire terminals. Wide choice of screw and friction lens caps with lenses of varied shapes and colors. T-3¼ bulbs can be had in 2 to 55 volt ratings; for commercial voltages NE-51 neon lamp can be used. With maker's built-in resistor these pilot lights can be used on voltages of 105-125 or 210-250.—*Dialight Corp.*, 60 *Stewart Ave., Brooklyn* 37, *N.Y.*

For more information circle **326** on inquiry card.

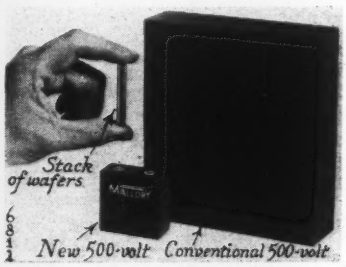
XEROGRAPHY PLATES

New dual-purpose "Plastiplates" give an exceptionally receptive plate (important in xerography) while doubling for conventional direct-image work; produce blacker copy of better contrast; also permit erasure of unwanted images and typing of additional copy even after fusing process has taken place.—*Remington Rand*, 315 *Fourth Ave., New York* 10, *N. Y.*

For more information circle **327** on inquiry card.

"SOLID STATE" BATTERY

New battery is said to be the first practical truly water-free primary energy source. Voltage is generated

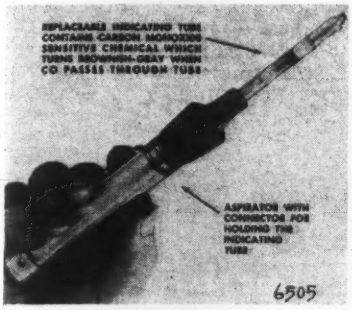


by difference in contact potentials between two conductors in contact with a solid electrolyte. Shelf life of ten years or more can be expected. Extremely small size per volt of output: 200 v from a one-cubic-inch unit. Output voltage is stable over temperature range from —65°F to 165°F. Simple design lends itself to automatic assembly. Present current capacities fall in microampere range. Among indicated applications: high-voltage calibration equipment, Geiger counters, high-voltage bias cells in electronic equipment operating at high ambient temperatures.—*P. R. Mallory & Co. Inc., North Tarrytown, N. Y.*

For more information circle **328** on inquiry card.

POCKET CO DETECTOR

New "Monoxor" pencil-size carbon monoxide detector shows at a glance if, in air being tested, carbon monox-

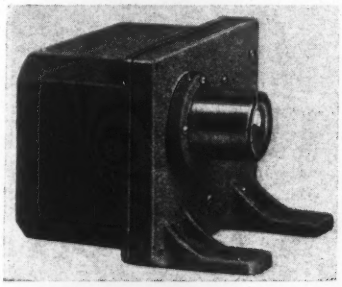

REPLACEABLE INDICATING TUBE CONTAINS CARBON MONOXIDE SENSITIVE CHEMICAL WHICH TURNS BROWNISH-GRAY WHEN CO PASSES THROUGH TUBE
ASPIRATOR WITH CONNECTOR FOR HOLDING THE INDICATING TUBE
6505

ide is present in any concentration which is dangerous for either occasional, short-time or long exposure; is particularly useful as a "safety check" on CO hazards in garages, mines, furnace rooms, and buildings where gas appliances are installed.—*Bacharach Industrial Instrument Co., 7301 Penn Ave., Pittsburgh 8, Pa.*

For more information circle **329** on inquiry card.

COMBINED TIMING AND PHOTOELECTRIC RELAYS

New control unit combines a photoelectric relay and a timing relay, both triggered by the same photoelectric



element. Photoelectric relay energizes when light beam is interrupted; timing relay energizes when timing period elapses while light beam is interrupted.—*Autotron Co., Box 722-Q, Danville, Ill.*

For more information circle **330** on inquiry card.

FERROMAGNETIC PLASTIC

New "Ferrotron" is a new ferromagnetic plastic in the forms of flexible rod and tape, which had been developed recently in the form of rigid powdered iron cores. Both the flexible and rigid materials are said to be suitable for continuous operation to 200°C; resist severe humidity; possess

SIEMENS
MEASURING INSTRUMENTS

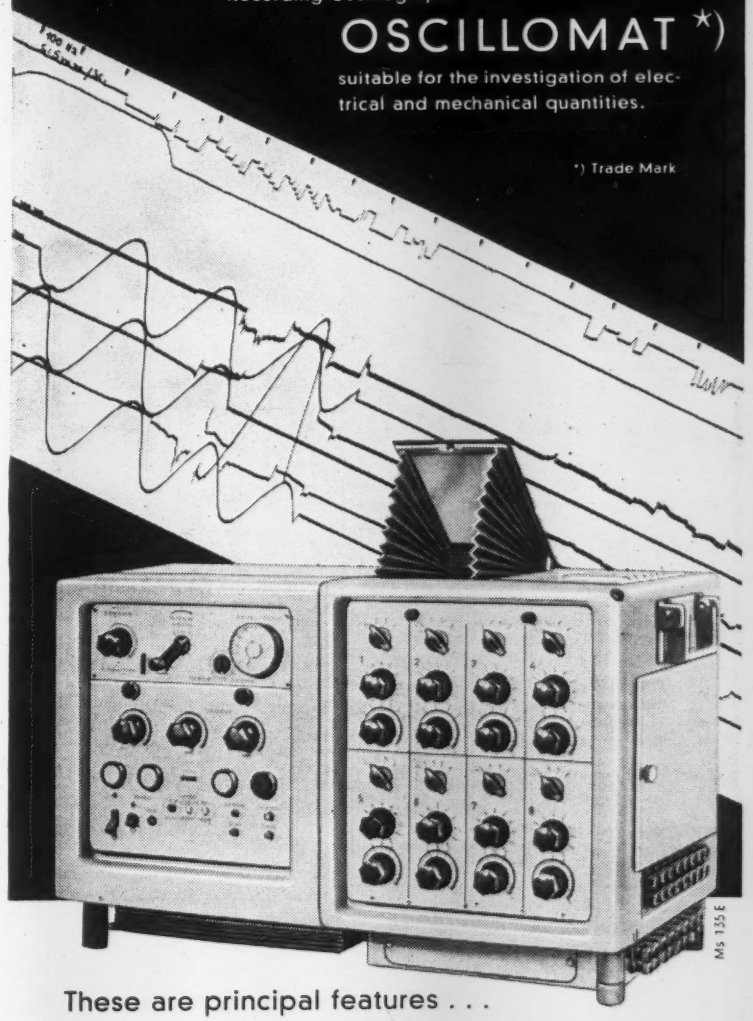
A high flexibility of operation

is achieved with our dependable Multi-element Recording Oscillograph

OSCILLOMAT *)

suitable for the investigation of electrical and mechanical quantities.

*) Trade Mark



These are principal features . . .

Automatic paper feed · Automatic paper stop · Automatic preparation for the next record · Automatic light-source control · Automatic record numbering · Automatic marking of record end · Remote triggering · Phenomenon-controlled records · Continuously variable paper speed from 0.0033 to 33 ft./sec · Linear frequency response up to 6,000 cps.

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For more information circle **115** on inquiry card.

PALMER
MERCURY ACTUATED

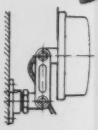
DIAL THERMOMETERS

in 3 types to suit any requirements

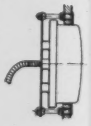
Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

1 **Rigid Stem Dial Thermometer** tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)

2 **Wall Mounted Dial Thermometer** with flexible connecting armor. Case adjustable to easy reading position.



3 **Flush Mounted Dial Thermometer** for panel mounting with flexible connecting armor.



All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensaton. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

Write for Catalog Information

PALMER
THERMOMETERS, INC.
Norwood Ave., Cincinnati 12, Ohio
Mfrs. of Industrial Laboratory Recording and Dial Thermometers

For more information circle 116 on inquiry card.

NEW INSTRUMENTS

high impact strength, good machinability, high volume resistivity and positive *Q* temperature coefficients. —*The Polymer Corp., Reading, Pa.*

For more information circle **331** on inquiry card.

MICRO-PROJECTOR

New "Tri-Simplex Micro-Projector" is designed for schools with low budgets. Teacher or pupil can easily use

it in three ways: (1) projecting microscope slides onto a wall screen; (2) projecting images of living microorganisms in liquid onto a wall screen; (3) projecting images for tabletop tracing.—*Bausch & Lomb Optical Co., Rochester* 1, *N. Y.*

For more information circle **332** on inquiry card.

SUBMINIATURE RATE GYROSCOPE

New rate gyroscopes, 1"Dx2⅛"L, are said to "offer excellent application possibilities for all types of con-

trols." They withstand extremes of shock, vibration and temperature fluctuation. Rate range 10 to 500 deg/sec; natural frequency 8 to 75 cps (undamped), depending on rate range. —*Robey Rotor Div., J. B. Rea Co.,* 1723 *Cloverfield Blvd., Santa Monica, Calif.*

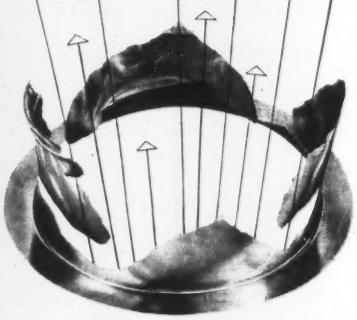
For more information circle **333** on inquiry card.

STATIC ELIMINATOR

New "Statikil" is a chemical guaranteed by maker to stop static electricity. It contains no mineral oils, radium, mercury, or harmful acids and is non-toxic.—*Dept. P, Statikil Div., The J. E. Doyle Co.,* 1220 *W. 6th St., Cleveland* 13, *Ohio.*

For more information circle **334** on inquiry card.

Instant automatic release of excess pressure



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rupture discs

in corrosion resistant precious metals and base metals

Send for free booklet, "Baker Rupture Discs". Helps you select the disc that meets your needs.

BAKER & COMPANY INC PRECIOUS METALS

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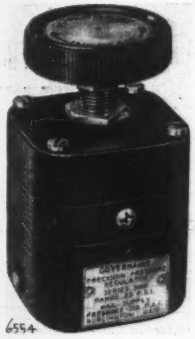
ENGELHARD INDUSTRIES

For more information circle 65 on inquiry card.

AIR PRESSURE CONTROLLERS

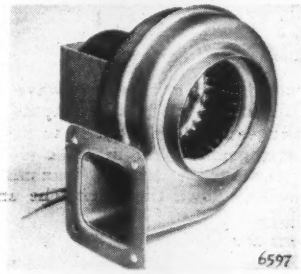


New "Series 5000 Piloted Regulators," for remote setting of controllers, for pneumatic gaging applications, and for laboratory use, are said to be the first instruments to combine 0.1% accuracy with small size and simple functional design, and to be "virtually primary standards of measurement." Exceptional accuracy and freedom from drift is mostly due to use of "Ni-Span C" measuring element which is hysteresis-free and does not vary under operating temperatures. Available in 25-psi and 60-psi standard ranges, for ⅛" and ¼" pipe sizes. All have a ¼" NPT tap for a gage. Flow capacity exceeds 6 scfm.—*Governaire Div., Bellofram Corp., Burlington, Mass.*

For more information circle **335** on inquiry card.

SMALL BLOWERS

New "Trade-Wind Series PA-361," for cooling electronic equipment, are direct-connected blowers producing up

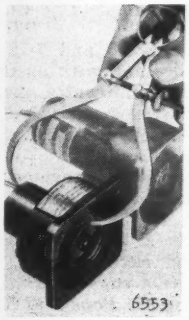


to 130 cfm with shaded-pole motors.—*Electronic Sales, Trade-Wind Motorfans, Inc., 7755 Paramount Blvd., Rivera, Calif.*

For more information circle **336** on inquiry card.

VARIABLE FREQUENCY BLOWER

New subminiature "Type SC" blower for use on variable-frequency power systems, is designed for single-phase operation, and requires only one phasing capacitor. For frequencies between 320 and 1,000 cps, air flow varies between 42 and 30 cfm at zero back-pressure. Frequency range can be extended to 1400 cps if further reduction in air flow to 18 cfm is permissible.—*Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.*

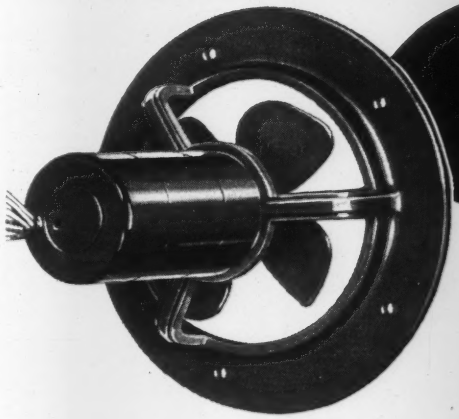


For more information circle **337** on inquiry card.

RING-MOUNTED

PRECISION-BUILT

MINIATURE FAN UNITS



400 CYCLE Variable Frequency

EAD's ring-mounted fans are designed for quick, easy installation in avionic and electronic equipment. Designed for peak performance, compactness, and versatility, these units utilize blade diameters as small as 2"—with air delivery greater than many heavier blowers. These fan units, using motor sizes from 1" to 2" in diameter, are designed to meet your most rugged conditions. There is a ring-mounted fan for your requirements. Write for complete technical and performance data.

REPRESENTATIVE UNITS							
Air Delivery at 0" S.P.	Air Delivery at .5" S.P.	Blade Dia.	Voltage	Frequency	Input (Watts)	Phase Data	Basic Type Numbers
180	145	3¾"	115	400	90	1	F4H92H
65	30	3"	115	400	15	1	F2HIT
32	15	2"	115	400	10	1	F2H90U

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

INDUCTION MOTORS · CENTRIFUGAL BLOWERS · TACHOMETER GENERATORS · FANS · ALTERNATORS · GEAR MOTORS

347 CENTRAL AVENUE • DOVER, NEW HAMPSHIRE

For more information circle **117** on inquiry card.

Briefs

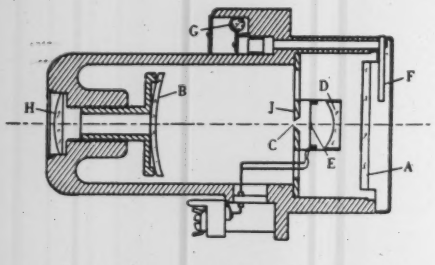
For this literature circle number on inquiry card.

Radiation Pyrometry

The Stefan-Boltzmann law states that the total radiation per unit area and per second from a blackbody; i.e., a body which has an emissivity of unity, is proportional to the fourth power of its absolute temperature:

$$W = \delta T^4$$

Where W is the radiant flux per unit area, δ is the Stefan-Boltzmann constant, and T is the absolute temperature in degrees K.



The receiver must be sensitive to small changes in t. It may be a bimetallic spiral actuating a pointer, a capsule in which gas pressure changes with changing temperatures, or a strip of blackened platinum forming one arm of a Wheatstone bridge. Most commonly it is a small, blackened metallic disk, the temperature changes of which are measured by the emf generated by a thermocouple or a thermopile.

The most conspicuous and fundamental classification of Rayotubes is that based on their means for collecting the radiation and focusing it on the receiver. There are three systems in use—the single mirror, the double mirror and the lens.

The sensitivity of a Rayotube may be rated on the basis of the lowest temperature at which it produces a significant emf. For the 8- and 12-junction elements this minimum emf has been chosen as 0.9 mv where the potentiometer is calibrated to measure up to a minimum of 20 mv.

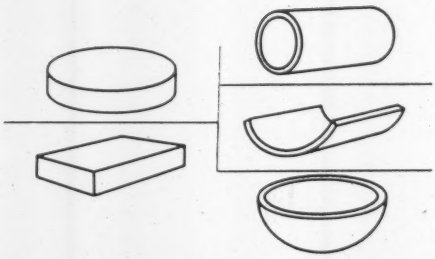
While all three of the focusing systems are available and will probably continue to be produced, the two-mirror system is expected to replace the other two for practically all applications, since it includes the best features of both. (*From* 48-*page monograph on theory, design and use of Rayotubes, by P. H. Dike, Ph. D., Techn. Pub. EN-33 B* (1), *Leeds & Northrup Co.*, 4901 *Stenton Ave., Philadelphia* 44, *Pa.*)

For this literature circle **401** on inquiry card.

Piezoelectric Ceramic Transducers

Transducers fabricated from ceramics—as compared to devices formed from quartz, rochelle salts, ADP, and tourmaline to mention a few—are the most versatile transducers available to industry.

The ability to form ceramic transducers to any size and shape permits a multitude of design functions, focusing actions and mountings while at the same time efficiency is increased and machining to close tolerances becomes practical. Ceramic transducers are strong and rugged,



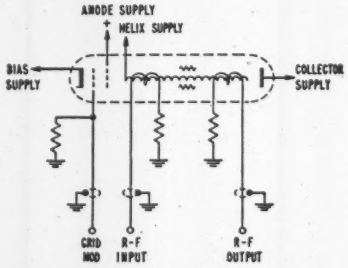
can handle large amounts of power, and can be electroded as required. Over-all characteristics of the ceramics—coupling coefficient, dielectric constant, temperature stability, sensitivity—are generally superior to those of natural materials found in other transducers.

A few of the many successful uses of piezoelectric ceramic transducers are in underwater sound equipment, ultrasonics, medicine, shock and vibration metering and others. (*From new* 10-*page brochure, Gulton Mfg. Corp., Metuchen, N. J.*)

For this literature circle **402** on inquiry card.

TWT Amplifiers

The new amplifiers consist of a traveling-wave tube with suitable power supplies and modulation inputs. The mechanism of the traveling-wave tube itself is to produce amplification by transferring energy from a d-c electron beam passing axially through a helical transmission line to the r-f wave traveling down the helix. The amplifiers operate over the 4-8 and 7-12.4 kmc ranges with gains of 25db or more and with maximum power outputs greater than 10 and 5 milliwatts, respectively, at 50-ohm input and output levels. A modulating grid enables the amplifiers to be used to pulse- or amplitude-modulate the r-f wave.

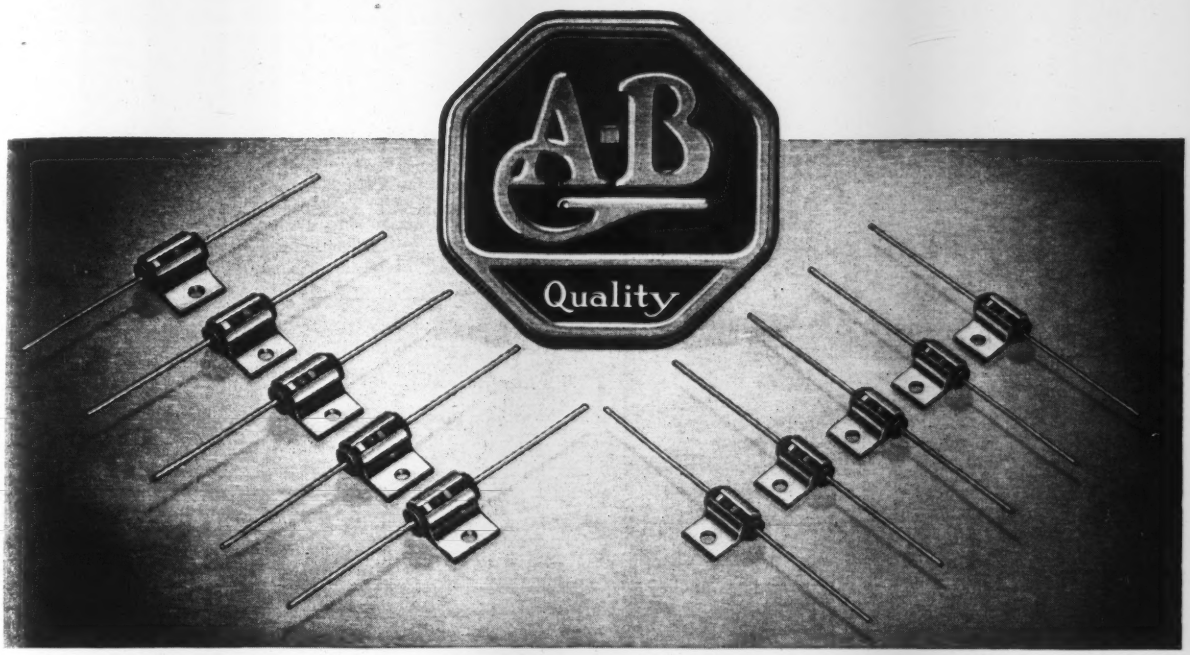


The special modulation arrangements provided in these amplifiers permit them to be used for producing a number of special signals at microwave frequencies. Included among these signals are offset carriers, combined sine- and pulse-modulated carriers, and frequency-modulated carriers. (*From new* 4-*page Journal Vol.* 7, *No.* 5, *The Hewlett-Packard Co.*, 275 *Page Mill Rd., Palo Alto, Calif.*)

For this literature circle **403** on inquiry card.

Transmitting Potentiometers

The series 184 Transmitter is a continuously balanced potentiometer using a design principle that eliminates



ALLEN-BRADLEY COPPER CLAD MOLDED RESISTORS

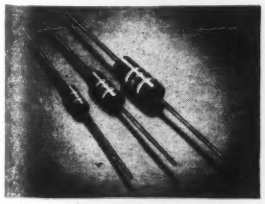
rated at 3 and 4 watts at 70C Ambient Temperature

A new and important addition to the Allen-Bradley line of radio, electronic, and television components are these Types GM and HM copper clad Bradleyunits, each fitted with a heavily tinned copper clamp. These new resistors are designed to be attached to a metal panel or chassis with rivets, bolts, or self-tapping screws. If attached to a metal panel four inches square and 0.050 in. thick at an ambient temperature of 70C, the maximum continuous wattage rating of the Type GM Bradleyunit is 3 watts; the Type HM Bradleyunit is 4 watts. At 40C ambient temperature, the ratings are 4 and 5 watts, respectively. However, if these copper clad Bradleyunits are suspended by their leads without being bolted to a metal panel, their respective ratings are 1 and 2 watts.

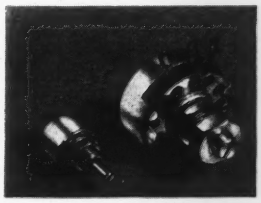
The copper clamp does not completely encircle the Bradleyunit, thus leaving a slot through which the color-code bands are plainly visible. Type GM Bradleyunits are available in all RETMA values from 2.7 to 22 megohms and Type HM Bradleyunits from 10 ohms to 22 megohms.

Allen-Bradley Co., 140 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

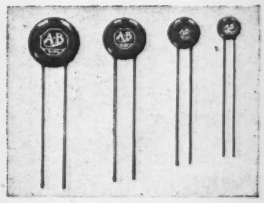
OTHER QUALITY COMPONENTS FOR RADIO, TV & ELECTRONIC APPLICATIONS



BRADLEYUNITS
½, 1, 2, 3 & 4 WATT



BRADLEYOMETERS
½ & 2 WATT



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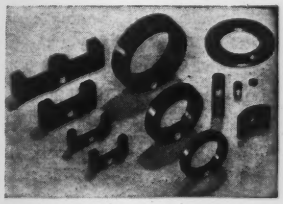

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slidewires, convertors or choppers, batteries, and other components which complicate usual self-balancing potentiometers.

Self-balancing action is achieved by use of the "Microsen" balance illustrated (Fig. 2a). The input voltage signal moves a pivoted beam in the vicinity of an oscillator coil and causes current to flow in the plate circuit of a vacuum tube. This creates an unbalance in a bridge circuit so that the output from the bridge is linearly proportional to the input signal.

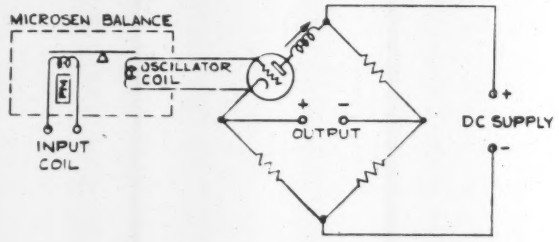


Figure 2a

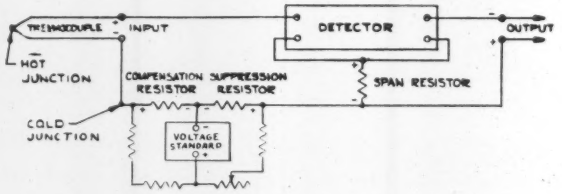


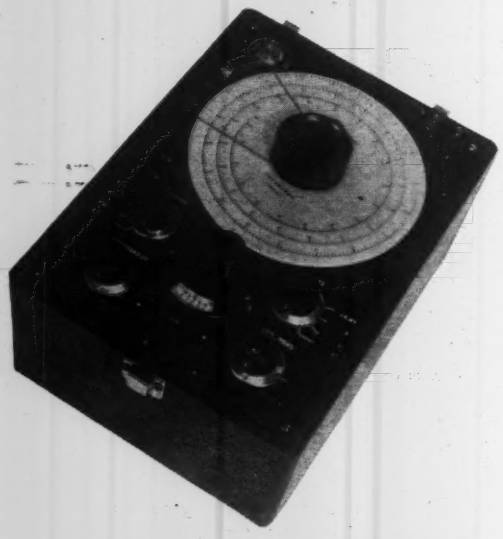
Figure 2b

☑ PYROMETERS

☑ THERMOCOUPLES

☑ TEMPERATURES

THE PYROTEST



CHECKS THEM ACCURATELY QUICKLY

The Pyrotest is a rugged, accurate, portable potentiometer with direct-reading temperature scales and a built-in millivolt source. It is designed to test recorders, controllers and indicators, and to make high-accuracy temperature measurements both in the plant and laboratory.

FEATURES

Instrument includes direct reading temperature scales for iron-constantan, chromel-alumel, platinum-13% Rh, and Platinum-10% Rh couples; also millivolt scale. Scales can be changed in less than 1 minute. Copper-constantan scale also available.
Effective scale length, 50"
Accuracy 1/6 of 1%
Cold-junction compensation
Self-contained millivolt source.
Powered by long-life mercury batteries.
For complete specifications write for Form 112.

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Berkeley news notes

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- *continuous-duty reliability!*
- *long component life!*
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COUNT CAPACITY: 5 DIGITS
TIME BASE: 0.1, 1 OR 10 SEC
ACCURACY:
± 1 EVENT, ± 50 PPM
INPUT:0.3 MA P-P INTO 10K LOAD
PRICE (F.O.B. FACTORY): $1,495.00

Measures events occuring during precise 0.1, 1 or 10 sec time interval, displays results in digital form. Operates from photocell, magnetic pickup or any suitable transducer to measure pressure, temperature, flow, velocity, viscosity, frequency, rpm, or to count events or objects at rates to 40,000 counts per second.
Only three vacuum tubes used (35 in comparable electronic model) in rf oscillator-power supply operating at low levels. Has digital "count-down" time base for precise gating; no adjustment of time base required.

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Berkeley
division of Beckman Instruments Inc.
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81 *TM

For more information circle **120** on inquiry card.

In series 184 Transmitting Potentiometer, the output signal is fed back to the input so it flows through the same (span) resistor as the input signal (Fig. 2b). The current of these two signals is in opposite directons so that the two voltages cancel. Thus the input signal voltage is null-balanced by an equal and opposite output voltage.

Range suppression and automatic cold junction compensation are achieved by introducing controlled voltages into the input circuit with the input signal voltage. The voltage standard (Fig. 2b) is a unit similar to the "Microsen" balance and amplifier shown in Fig. 2a.

The output signal is 0.5 to 5.0 ma direct-current signal. Transmission loop resistance can be up to 3000 ohms, the equivalent of 30 miles or more. (*From new 4-page Bulletin MTT810, Manning, Maxwell & Moore, Inc., Ind. Controls Div., Stratford, Conn.*)

For this literature circle **404** on inquiry card.

Chronometrically Governed D.C. Timing Motors

Power pulses at full line voltage are applied to a small motor at intervals, controlled by a jewelled escapement, with the pulse duration determined by travel of the motor. This method holds motor travel constant during each time interval regardless of load (within rating). As a result heat rate is held constant within ± 0.1 percent for line voltage variations of ± 20 percent and load variations from zero to full load.

As a primary source for precision time control, the balance wheel and hairspring mechanism has several advantages. It can be designed to be relatively unaffected by changes in position, temperature, magnitude of driving force, vibration or gravity, and in addition requires relatively slow motion as compared with a tuning fork. Its major limitation, low power transmittal, might

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For more information circle **122** on inquiry card.

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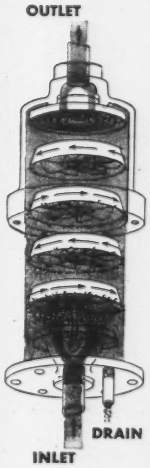

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or vibrating cold?

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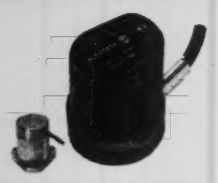

Whether you want to measure vibration near a jet engine or on equipment designed for Arctic use, there's a CEC *self-generating* Vibration Pickup to do the job. Various models are usable from −65° to +500°F ...in any position and with *absolute* freedom from sticking at low frequencies or amplitudes. For either direct reading on vibration meters or recording through oscillographs, they're ideal for sensing vibration... accurately and dependably.

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Frequency Response..... 4-102A..Flat ±5%, 8-700 cps @ 80°F
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4-118...Flat ±10%, 50-500 cps @ 100°F

Temperature Range..... 4-102A.....0 to 150°F
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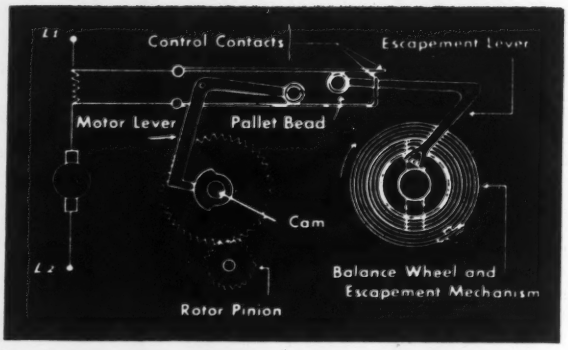
BRIEFS—CONTINUED



be overcome by a d-c motor provided timing was not disturbed in controlling motor speed. This is the approach used in the new "chronometric governor."

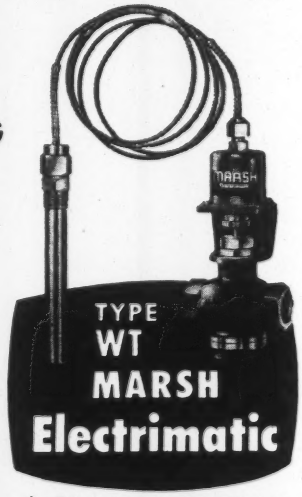
Principal of operation is shown. The motor is geared directly to a cam-operated lever extending between a pair of leaf spring contacts and so arranged that its motion in either direction opens the contacts. Also located between the contacts is a pallet bead, insulated but mechanically attached to the clock escapement lever in such a manner that the clock escapement merely releases these contacts allowing them to close while the motor operated cam does the work of opening the contacts. The contacts are connected directly in series with the motor so that the faster the motor tries to go, the quicker the contacts are opened; yet they close at regular intervals as released by the escapement.

The unit is reliably self-starting. (*From new 2-page Bulletin A.W.H. MO 800, The A. W. Haydon Company, Waterbury, Conn.*)

For this literature circle **406** on inquiry card.

MARSH QUALITY

... in a Temperature-actuated
REGULATING VALVE



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A temperature actuated regulating valve you can depend on—the Marsh Electrimatic Type WT for pressures up to 150 psi, water or brine, and up to 15 lbs. for steam (250° maximum temperature). It opens as temperature rises, closes as temperature falls, to give an ideal, smooth, modulated control. Can be mounted in any position; serviced without breaking connections. Seat beads are monel to eliminate wire drawing. Sturdy, two-ply bellows assures extra service life. Temperature ranges of 20°F.-60°F.; 60-100, 100-140, 140-180, 160-220. All standard sizes from ⅜" through 4". All styles of temperature bulbs.

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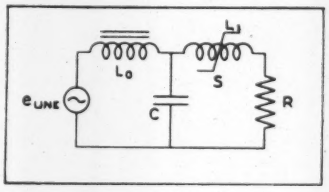
For more information circle **126** on inquiry card.

Magnetic Pulse Generator

The magnetic Pulse Generator uses saturable reactors instead of thyratrons as discharge devices. The unit is basically a capacitor type pulser in which electrical energy storage is achieved by means of AC-Resonant charging. High pulse powers are obtained by rapid discharge of the condenser through saturable reactors. These reactors are



in appearance and construction similar to transformers and act as static magnetic switches.

The basic pulse generating circuit as shown in Fig. 1 is a "flux oscillator."

The linear Inductor L_0 and storage capacitor C are in resonance with the line frequency. In the well-known resonant-charging process the capacitor C will be charged according to Fig. 1b and practically the same voltage will appear across the magnetic switch S since the IR drop due to magnetizing current is negligible.

Its applications are: radar, production testing, magnetron tester, magnetic core tester, to provide for a reliable high performance pulse power supply without elaborate circuits. (*From new 4-page Engineering Bulletin EB-204, Magnetic Research Corp., 200-202 Center St., El Segundo, Calif.*)

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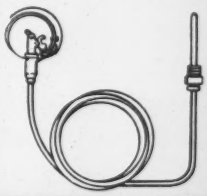

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MICRO DELTA-P controller

this Back Pressure Controller Emphasizes

- SPEED
- ACCURACY
- SIMPLICITY
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Bulletin 542 gives you all the details. Write:

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Available in standard dials (reading in inches of water) 0-15" —0-30" —0-60" —0-100" —0-160" ...also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

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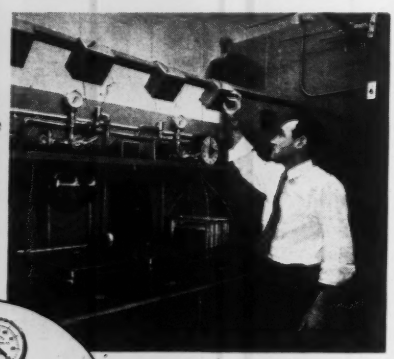

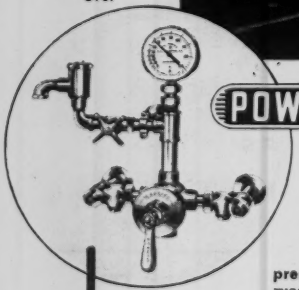

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Supply Fixture 4629PD, used above by AUTHENTICOLOR Laboratories, N.Y. City, thermostatically mixes hot and cold water and delivers the mixture at any constant temperature desired—regardless of **pressure** or **temperature** changes in water supply lines. Failure of cold water instantly and completely shuts off the delivery.

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(b56)

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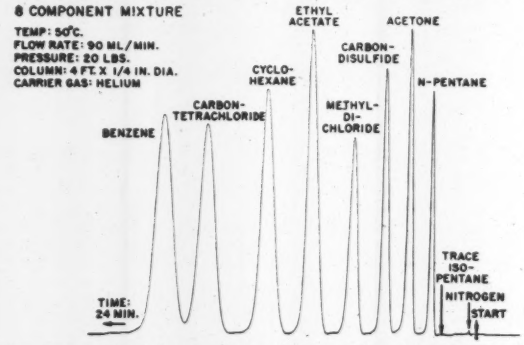
BRIEFS—CONTINUED

Vapor Fractometer

The Perkin-Elmer Model 154 Vapor Fractometer is a powerful new tool for the analysis of gases and liquids boiling below 300°C. It is based on the principle of gas chromatography, which makes use of the different affinity one material may have for another to separate the various components in a mixture. Either the "Elution-Partition" or "Elution-Adsorption" techniques may be employed in this instrument. The former provides best results for liquids boiling above room temperature while the latter is best for gases.



The instrument consists of a sampling system, an interchangeable column in a thermostated enclosure, and a detector together with necessary controls. The signal produced by the detector may be fed into any standard 10-millivolt recorder without an intermediate amplifier. (*From new 6-page pamphlet, The Perkin-Elmer Corp., Norwalk, Conn.*)

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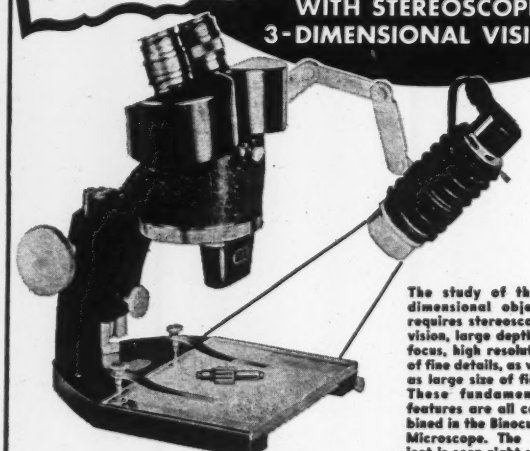

The study of three dimensional objects requires stereoscopic vision, large depth of focus, high resolution of fine details, as well as large size of field. These fundamental features are all combined in the Binocular Microscope. The object is seen right side up in both directions.

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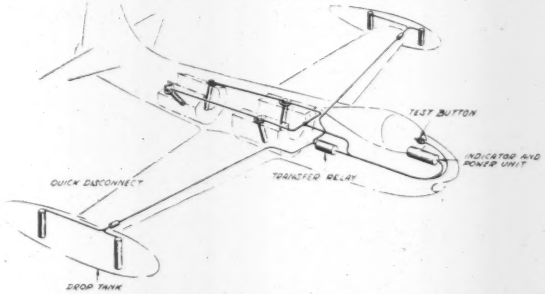
200-MG LAFAYETTE STREET • NEW YORK 12, N. Y.
For more information circle **132** on inquiry card.

Capacitor Type Fuel Gages

There are 3 basic gages: (1) the uncompensated system, (2) the compensated system, and (3) the true weight system. The first two systems utilize a self-balancing



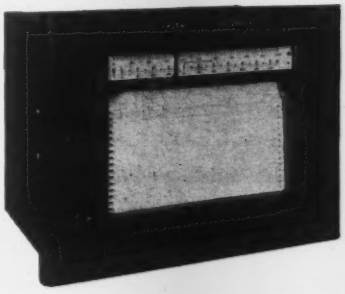
capacitance bridge circuit. The tank unit, a tubular capacitor located in the fuel tank, forms one leg of the bridge. Tank unit capacitance varies with fuel level and fuel dielectric constant. Because fuel density is related to its dielectric constant, tank unit capacitance is related to the weight of the fuel remaining. This capacitance is measured by the bridge network and displayed on the indicator as pounds of fuel remaining.

The compensated gage makes use of a reference sensing element which tends to correct for changes in dielectric constant with respect to fuel density.

The true weight system considers dielectric constant and density as two independent variables. It measures volume by means of a tank unit and a reference condenser and density by means of a density sensitive rheostat. Because it responds to volume and density only it indicates the true weight of the fuel being measured.

Thermistors immersed in the fuel can act as a fuel level warning. Immersion in fuel will cool the thermistor

PHOENIX RATIO RECORDER PLOTS RATIO OF TWO VARIABLES V_1/V_2



Recorder has dual scale. One for conventional recording of 0 to 5 millivolt signals. Second scale for ratio of any two (2) D.C. signals. Pressures, temperatures, speeds, torques, force, displacements and photo-electric signals are ratioed directly by this instrument. Recorder operates with high or low impedance input devices. Change of 0.01 millivolt in either variable will produce a change in recorded ratio.

Phoenix Precision Instrument Co.
3803-05 N. 5th St. Phila. 40, Pa.

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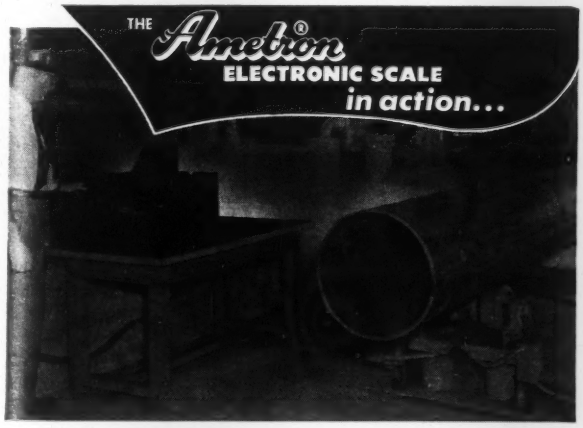

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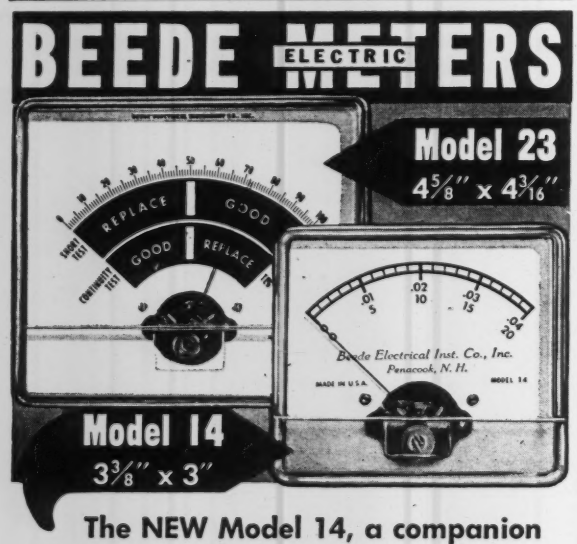

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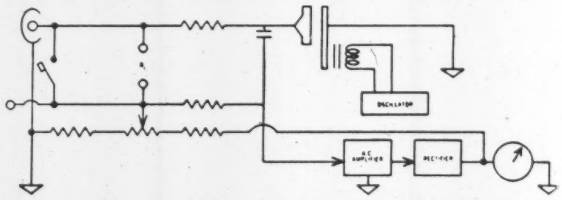
and thus bring about a substantial change in its resistance. This characteristic change is used to actuate a warning and control systems. (*From new* 16-*page "Liquidometer Systems," Liquidometer Corp.,* 36-27 *Skillman Ave., Long Island City, L. I., N. Y.*)

For this literature circle **408** on inquiry card.

Vibrating Reed Electrometer

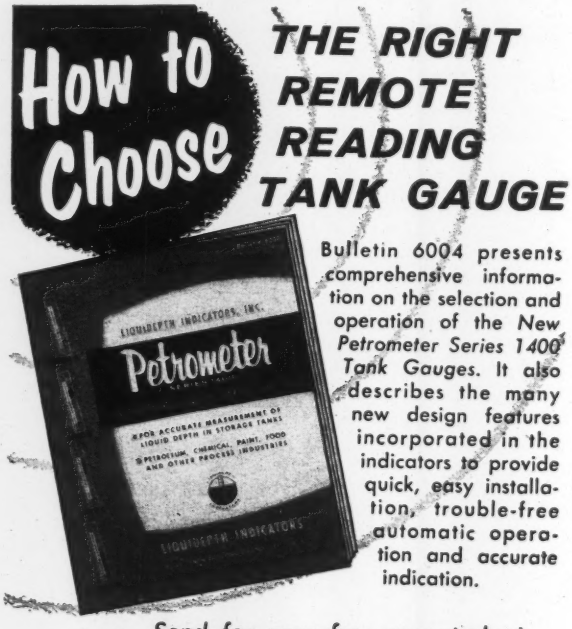
The Cary Model 31 Vibrating Reed Electrometer is an instrument for measuring very small currents, charges, and voltages. It is capable of detecting a current as small



as 1.0×10^{-17} ampere originating in a high-impedance source. Charges as small as 5×10^{-16} coulomb and voltages as small as 0.02 mv can be measured.

In the vibrating reed electrometer, the DC input signal is converted to AC by using mechanical energy to move the impressed charge through an electrostatic field. The AC signal thus produced, which is a measure of the impressed charge, is amplified in a stable AC amplifier and then rectified and used to drive the indicating meter. A portion of the rectified AC is applied as negative feedback to give very high stability.

The charge to be measured, applied at I, produces a DC voltage across the vibrating reed capacitor C_V. The electromagnet and oscillator cause the reed to vibrate at a frequency of 450 cps so that the capacity of C_V varies at this frequency. This produces a 450 cps voltage across C_V which is proportional to the impressed DC signal.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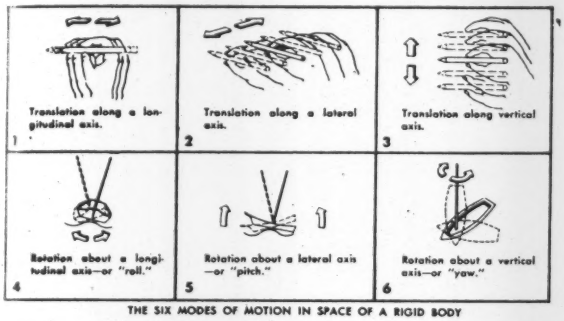
Applications include radioactivity measurement, C^{14}, H^3, S^{35} determinations, mass spectrometry, pH determination, electrical properties (such as large resistance values, dielectric properties of insulating materials and semiconductors, capacitance, dielectric constants, etc.) (*From new 6-page folder, Applied Physics Corp., 362 W. Colorado, Pasadena 1, Calif.*)

For this literature circle **409** on inquiry card.

Vibration Control

Vibration is seldom confined to a single, simple motion. If it were, control would become a fairly simple matter. But even a rigid body has six degrees of freedom in space (or, technically speaking, six modes of motion). Complex structures have even more modes of motion, involving the relative motion of various rigid bodies, or distortion of flexible bodies. In general, vibration problems lie in the six fundamental motions. Any of these modes may be excited by vibratory forces.

Effective vibration control calls for absorption of all the possible modes of motion of a product. A flexible mounting which is soft in one direction only fails to iso-



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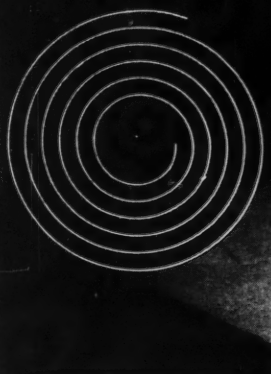

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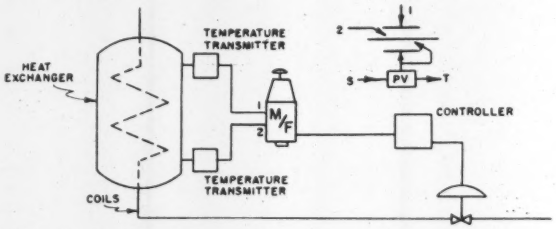
late all modes. The MB ISOMODE mount is designed with equal spring rates in all directions.

The ISOMODE Design Chart is a space plot upon which the scaled outline of the body to be isolated can be projected. The best selection of mount points and mounts for a suspension of the body can be obtained by the independent consideration of the projections of the physical body on each of the three orthogonal planes containing the principal inertia axes of the body. (*From new 12-page Bulletin 616, the MB Manufacturing Co., Inc., 1060 State St., New Haven 11, Conn.*)

For this literature circle **410** on inquiry card.

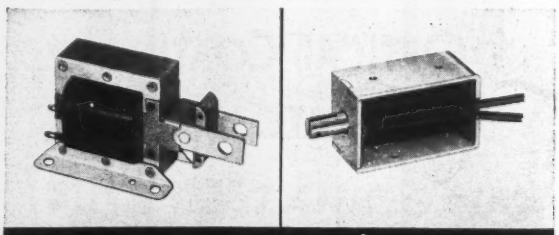
Multi-Function Relays

NULLMATIC M/F relays provide solutions to many control problems which involve interlocking and multi element circuits. The pneumatic force-balance operation



of these instruments and the many circuits which are available through re-assembly offer a seemingly endless number of functions . . . . Application engineers have compiled a series of reports showing some of the widely used applications. All of these reports are based on actual installations. A multi-element control setup is shown for control of problem.

Solution: An M/F relay—Model 68-3, Figure 7 (averaging). The signals form two transmitters, located at



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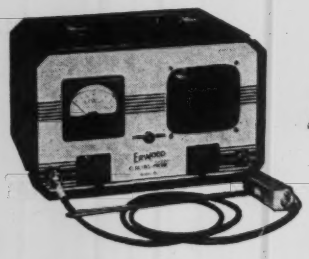

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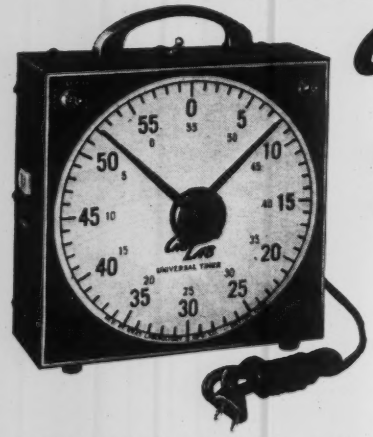

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appropriate points, are averaged by the M/F relay. An average signal is sent to the controller.

(*From new 32-page Bulletin AD 68, Moore Products Co., 901 E. Lycoming St., Philadelphia 24, Pa., which includes 19 case histories of typical process control problems.*)

For this literautre circle **411** on inquiry card.

Mercoid Controls

Mercoid diaphragm operated pressure controls are designed for use on low pressure applications where the control circuit is required to operate from changes of fractions of inches of water (pressure).

Differential pressure controls are used for high pressure applications—to "make" or "break" an electrical circuit on changes in the difference between two pressures.

The terminology used for differential pressure control is somewhat different than that used for standard single pressure controls. In a standard pressure control, differential is the change in pressure required to restore the electrical circuit to its original position after it has operated. In a Differential Pressure Control, however, the change in pressure difference required to restore the circuit to its original position after it has operated is the sensitivity. For example; if the control is set to open its circuit when the difference between two pressures increases to 5 psi, and the circuit is restored to the original position (closed) when the pressure difference decreases to 4 psi, the difference between the 5 psi (original operation) and the 4 psi (resetting point) is the control sensitivity of 1 psi.

Mercoid Remote Bulb Temperature Controls are adaptable to a wide number of applications. (*From new 56-page Catalog 856, The Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.*)

For this literature circle **412** on inquiry card.

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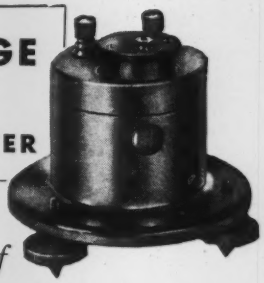

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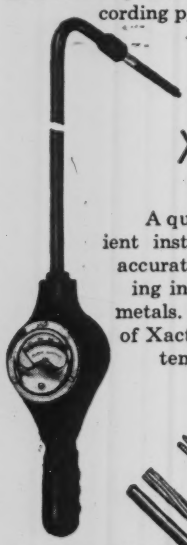

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INSTRUMENTS and AUTOMATION

New Literature

VALVES

Air Control Valves. New 4-page catalog describes 17 combinations of flow control, pilot, cam, hand or foot, sequence, solenoid, single and double solenoid pilot air-control valves.—Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.
Circle **413** on inquiry card.

Pressure Reducing Valves. New 4-page Form 1009 describes maker's line of direct-operated, water-pressure reducing valves.—Spence Engineering Co., Inc., Walden, N. Y.
Circle **414** on inquiry card.

Valves. New 4-page Bulletin 1027 describes maker's new diaphragm-type and piston-type control regulating valves for pressure, temperature, liquid level control.—Copes-Vulcan Div., Blaw-Knox Co., Erie 4, Pa.
Circle **415** on inquiry card.

High-Pressure Valves. New Bulletin 10, with supplements, describes maker's new line of stainless valves and fittings for pressures up to 25,000 psi. —Inferno Co., P. O. Box 1138, 115 Ricou St., Shreveport, La.
Circle **416** on inquiry card.

Valves, Draft Gages. New 30-page Bulletin 1600-B describes maker's ports, levelometers, valves, pumps, heaters, draft gages and controls for heating plants, boiler houses, etc.—Preferred Utilities Mfg. Corp., 1860 Broadway, New York 23, N. Y.
Circle **417** on inquiry card.

Motor Operated Valves. New 4-page Bulletin V562 presents maker's line of two-position, motorized valves for water and steam.—National Controls, Inc., Newton Centre 59, Mass.
Circle **418** on inquiry card.

3-Way Selector Valves. New 2-page Data Sheet Series 6000 presents maker's new line of 3-way solenoid-operated selector valves for 3000-psi hydraulic service that permit flow in any direction.—Aircraft Products Co., 300 Church Road, Bridgeport, Pa.
Circle **419** on inquiry card.

Hydraulic Valves. New 8-page Bulletin A-5209 describes maker's line of 17 special and standard oil-hydraulic valves for airborne application.—Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.
Circle **420** on inquiry card.

TEMPERATURE

Infrared Detectors. New 2-page Data Sheet D2 presents characteristics of new additions to maker's line of OptiTherm" thermistor type infrared detectors with controlled time constants ranging from 1.0 to 50 milliseconds.—Barnes Engineering Co., 30 Commerce Road, Stamford, Conn.
Circle **421** on inquiry card.

Surface Temperature Thermometers. New 2-page Data Sheet 235 describes maker's line of surface temperature thermometers in various ranges with magnetic and other clamps.—Pacific Transducer Corp., 11836 W. Pico Blvd., Los Angeles 64, Calif.
Circle **422** on inquiry card.

FLOW, PUMPS

Alternating Flow. New 8-page issue of "Instrument Notes" (No. 30) features "Alternating Flow of Fluid in Tubes" that describes how fluid masses respond to alternating pressures, and presents means for deriving accurate flow impedance values.—Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.
Circle **423** on inquiry card.

Hydraulic Pump. New 2-page Bulletin HPX-55 describes operation of maker's hydraulic pressure exchange pump for pumping abrasive and corrosive solutions up to 120 gpm at high temperatures without plungers, stuffing boxes, and packing.—Manton-Gaulin Mfg. Co., Inc., Everett, Mass.
Circle **424** on inquiry card.

High-Pressure Pumps. New 6-page Bulletin P-55 describes maker's horizontal, high-pressure, "Triplex" pumps, including selection graphs, power curves, etc.—Manton-Gaulin Mfg. Co., Inc., 44 Garden St., Everett 49, Mass.
Circle **425** on inquiry card.

Controlled Volume Pumps. New 8-page Technical Paper 64 describes several systems for process and waste water treatment utilizing controlled volume pumps to meter chemicals and additives.—Milton Roy Co., Station L, 1300 E. Mermaid Lane, Phila. 18, Pa.
Circle **426** on inquiry card.

PRESSURE

Manometers. New 4-page Bulletin G-10 describes range, working pressure and application of maker's line of U-tube to ultra-precision manometers, including specialized manometers for pressure, vacuum, flow, and liquid

level, electrical contactor-type and portable kits for field instrument calibration.—The Meriam Instrument Co., 10990 Madison Ave., Cleveland 2, Ohio.

Circle **427** on inquiry card.

Pressure Transducer. New 2-page bulletin describes maker's magnetic-reluctance-type pressure transducer for differential or gage pressure measurement from ±¼ to ±100 psi.—Pace Engineering Co., 6914 Beck Ave., North Hollywood, Calif.

Circle **428** on inquiry card.

Radar Pressurizing. New 2-page Data Sheet 2-89A describes maker's dual control panel for remote control and sensing of radar air pressurizing equipment.—Lear, Inc., Elyria, Ohio.

Circle **429** on inquiry card.

MONITORS

Industrial Signals. New 8-page Bulletin 100 describes how to select signals for general alarm, start and dismissal, coding or paging and danger.—Federal Sign and Signal Corp., 8700 S. State St., Chicago 19, Ill.

Circle **430** on inquiry card.

Monitor Alarms. New 4-page issue of the "Rambler" (Winter 1956) discusses custom engineering of automatic control systems and describes maker's "Multalarms."—Automatic Control Co., 995 University, St. Paul 4, Minn.

Circle **431** on inquiry card.

Indicator Lamp. New bulletin describes maker's ⅜" dia. indicator lamp available in colors and codes.—Circon Component Co., 17544 Raymer St., Northridge, Calif.

Circle **432** on inquiry card.

Indicator Lights. New 1-page bulletin presents maker's line of neon and incandescent indicator lights with digits or letters on face of lenses.—Eldema Corp., 9844 Remer Street, El Monte, Calif.

Circle **433** on inquiry card.

COMPUTERS

Computer Components. New 4-page bulletin describes maker's mechanical and electrical components for analog and digital computers.—Librascope, Inc., 808 Western Ave., Glendale, Calif.

Circle **434** on inquiry card.

Magnetic Storage. New 2-page brochure presents new group of matrices and driver transformers for use in mocking up magnetic memory systems.—Valor Electronic Components Co., 5808 Marilyn Ave., Culver City, Calif.

Circle **435** on inquiry card.

Add-Punch Machine. New 4-page brochure (Form A766) presents maker's adding and listing machine with a tape-punch mechanism that simultaneously punches data on tape according to programmed control codes.—Friden Calculating Machine Co., Inc., San Leandro, Calif.

Circle **436** on inquiry card.

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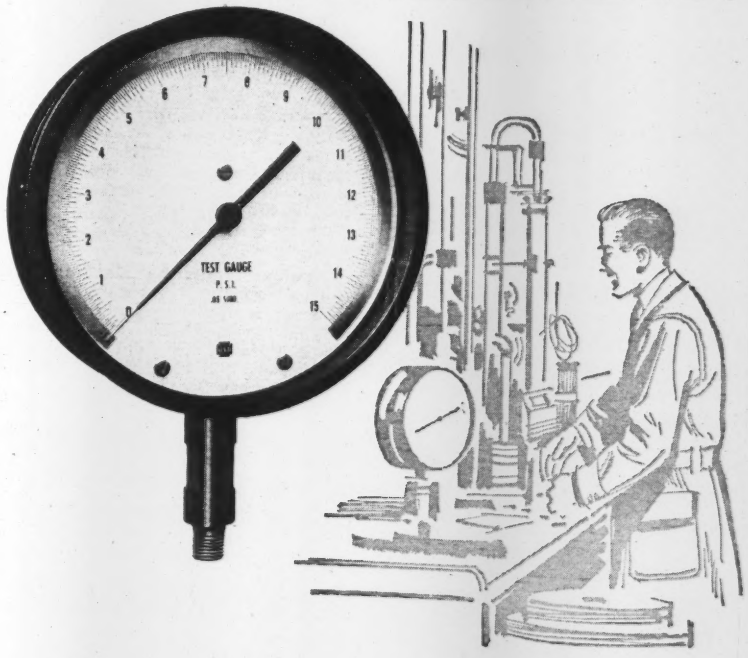

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For more information circle **150** on inquiry card.

NEW LITERATURE

Analog-to-Digital Conversion. New 6-page Reprint R-78 describes in detail three systems for analog-to-digital conversion by voltage converter systems, each providing a repeatability of one part in one thousand.—Beckman Instruments, Inc., Fullerton, Calif.

Circle **437** on inquiry card.

Operational Amplifier. New 2-page Bulletin K2-P describes maker's chopper-amplifier-stabilized operational amplifier.—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

Circle **438** on inquiry card.

Analog Computing Machines. New 8-page reprint discusses "Modern Analog Computing Machines" (from original presentation at computer seminar in NYC, Sept. 7, 1955).—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

Circle **439** on inquiry card.

RECORDING, DATA REDUCTION

X-Y Plotter. New 8-page bulletin bulletin describes maker's new X-Y plotters and input accessories used for graphic depiction of one independent variable in terms of another.—Librascope, Inc., 808 Western Ave., Glendale, Calif.

Circle **440** on inquiry card.

Digital Recording. New 8-page Booklet M-55-100 describes operation and features of maker's electronic digital recording systems.—Metrotype Corp., Michigan City, Ind.

Circle **441** on inquiry card.

Electronic Typer. New 4-page Bulletin 190-655-1 presents maker's printing device operated electronically from the output of an electronic computer or magnetic tape.—Shepard Laboratories, 480 Morris Ave., Summit, N. J.

Circle **442** on inquiry card.

Counters, Data Recorders. New 4-page "Short Form Catalog" presents features, and specifications of maker's frequency meters, universal counters and timers, digital recorders, data converters, preset counter controllers, EASE computers, etc.—Berkeley Div., Beckman Instruments Inc., 2200 Wright Ave., Richmond, Calif.

Circle **443** on inquiry card.

Calculating Typewriter. New 6-page Form 782 presents maker's "Computyper" that types invoices and automatically calculates and prints results of extensions, additions, discounts, sales taxes, and special charges and credits.—Friden Calculating Machine Co., Inc., San Leandro, Calif.

Circle **444** on inquiry card.

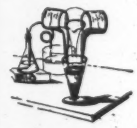
Recording Oscillograph. New 16-page issue of "CEC Recordings" (Vol. 9 No. 7) features use of maker's recording oscillograph for documentation of environmental performance test results.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **445** on inquiry card.

Data Reduction. New 4-page Bulletin 90-130-24 describes data logger and control center for pulp and paper works.—Fischer & Porter Co., 618 Jacksonville Road, Hatboro, Pa.

Circle **446** on inquiry card.

ANALYTICAL



Oxygen Analyzer. New 16-page Catalog 55-829-56 describes principle construction, operation and features of maker's paramagnetic type "Magno-Therm" analyzer and electronic recorder.—The Hays Corp., Michigan City, Indiana.

Circle **447** on inquiry card.

Ultraviolet Spectrophotometer. New 4-page Bulletin FD 106 describes maker's "Spectracord" featuring new double monochromator that eliminates stray light.—Perkin-Elmer Corp., Norwalk, Conn.

Circle **448** on inquiry card.

pH Meters. New 2-page application data sheet G-59-F describes use of maker's pH meters in quality control of bakery dough.—Beckman Instruments, Inc., Fullerton, Calif.

Circle **449** on inquiry card.

Rotational Viscometer. New 2-page Data Sheet 10911 describes maker's "Precision" interchemical rotational viscometer, a high-speed, instrument to measure viscosity and thixotropic break-down of paints, inks, etc.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **450** on inquiry card.

Infrared Analyzer. New 2-page Specification Sheet 475 describes maker's positive, non-dispersive infrared analyzer for use with gases or liquids in complex streams.—Beckman Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle **451** on inquiry card.

Combustible Gas Indicators. New 4-page Bulletin 0804-2 describes maker's new portable instruments for detecting and measuring flammable gases and vapors.—Mine Safety Appliances Co., 201 N. Braddock Ave., Pgh 8, Pa.

Circle **452** on inquiry card.

Spectrophotometric Reference. New 6-page brochure SA-56A provides reference table of spectrophotometric absorption cells and cell compartment assemblies.—Will Corp., Rochester 3, N. Y.

Circle **453** on inquiry card.

Spectroscopic Analysis. New 4-page Bulletin FS-258 describes maker's "Spectranal" for qualitative and semi-quantitative analysis.—Fisher Scientific Co., 360 Fisher Bldg., Pgh. 19, Pa.

Circle **454** on inquiry card.

Infrared Spectrophotometer Accessory. New 1-page bulletin A-8 de-

scribes maker's linear absorbance accessory that allows direct recording of linear absorbance over the range 0 to 1.0 absorbance unit.—The Perkin-Elmer Corp., Norwalk, Conn.

Circle **455** on inquiry card.

Gas Sampling System. New 2-page Bulletin A-7 describes maker's gas sampling system that introduces a measured and reproducible volume of gas into the "Vapor Fractometer".—The Perkin-Elmer Corp., Norwalk, Conn.

Circle **456** on inquiry card.

LABORATORY

Precision Glassware. New 4-page brochure describes precision glassware for electronic applications including capillary tubing from .004" to .1255" id with tolerance of ±0.0002".—Wilmad Glass Co., Inc., Franklin & Flower St., Landisville, N. J.

Circle **457** on inquiry card.

Laboratory Glassware. New 139-page Catalog CA-2 illustrates over 6,000 custom-made Pyrex glass apparatus items including 50 new pieces.—Laboratory and Pharmaceutical Sales Department, Corning Glass Works, Corning, N. Y.

Circle **458** on inquiry card.

Ovens, Chambers. New 8-page Bulletin D-4386 presents maker's line of laboratory equipment, including ovens, microscopes, centrifuges, stirrers, etc.—Harshaw Scientific, Harshaw Chemical Co., Cleveland 6, Ohio.

Circle **459** on inquiry card.

Laboratory Equipment. New 20-page "Announcer" (No. 56 2 61) features a story of rheology and describes maker's equipment, including rheometers, shakers, balances, heaters, ovens and centrifuges.—Burrell Corp., 2223 5 Ave., Pgh. 19, Pa.

Circle **460** on inquiry card.

Chemical Testing Equipment. New 4-page Bulletin G-1-56 describes maker's double-range phosphate comparator, pH comparators, and demineralizer.—LaMotte Chemical Products Co., Towson, Baltimore 4, Md.

Circle **461** on inquiry card.

Lab-Glass Washer. New 4-page Bulletin 2250 presents specifications and operation of maker's automatic washer for laboratory glassware.—Rochester Scientific Co., P. O. Box 163-38 Scio St., Rochester 1, N. Y.

Circle **462** on inquiry card.

Surfactants. New 12-page brochure describes services available to industry by surface chemistry consultants.—Foster D. Snell Inc., 29 W. 15 St., New York 11, N. Y.

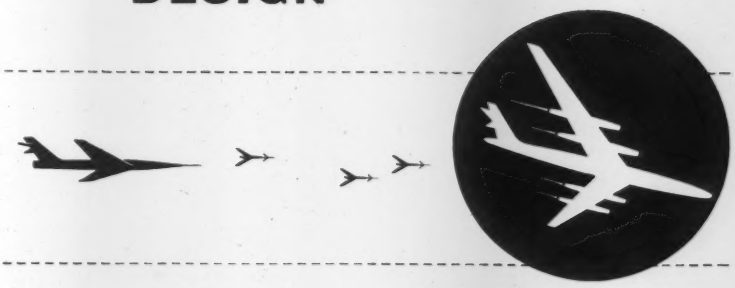
Circle **463** on inquiry card.

Woven Electric Heaters. New 4-page Bulletin F-1548A presents features, application data and suggested uses for maker's flexible woven electric heaters that can be wrapped or molded into shapes to maintain localized temperature requirements.—Edwin L. Wiegand Co., Pgh. 8, Pa.

Circle **464** on inquiry card.

Extend your future in

CIRCUIT DESIGN



At Hughes we have undertaken development of a system in which advanced radars using array antennas and newer traveling wave tube developments are combined with digital data handling and processing equipment to solve the complex problems of aircraft detection and assignment.

We are already in an enviable position in the intercept and destruction phase of defense through the Hughes airborne radar fire control systems and the Hughes Falcon guided missile. Achievement of these objectives in the very limited space and stringent environmental conditions of the modern defense system provides an unusual challenge to the creative circuit design engineer.

If you are interested in joining us you should have experience in one or more of the following circuit areas:

Transistor—Video—Microwave—Pulse—IF and RF—Switching—Clamping—Phase Shift—Power Supply—Modulator—Electromechanical.

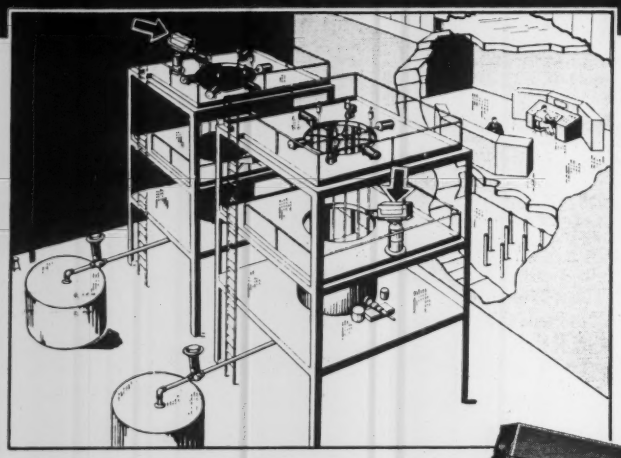
Scientific Staff Relations

HUGHES

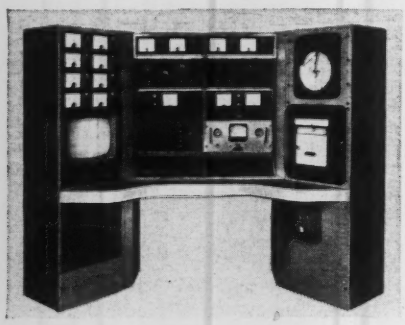
RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

Diamond "UtiliVue"
(WIRED TELEVISION)
used in NUCLEAR REACTOR STUDIES
at Battelle Memorial Institute



Arrows indicate remotely controlled "UtiliVue" Cameras that SEE experimental nuclear reactor cores.



"UtiliVue" Monitor is built into control console in separate control room where experimental nuclear reactor cores can be WATCHED in perfect safety.

"UtiliVue" pedestal enables camera to be rotated 320° and tilted 90° by remote control from console. Zoom lens (also controlled from console) brings objects into focus at widely varying distances from camera.

The "UtiliVue" is invaluable whenever there is the need for actually SEEING what is happening where it is impossible or impractical for the human eye to watch directly. There are installations of Diamond Industrial TV that have been in continuous operation since 1946. For further information, get in touch with your Graybar Distributor or use the coupon below.

7406

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"FIRST IN INDUSTRIAL TELEVISION"
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Name_____

Title_____

Company_____

Address_____

For more information circle **151** on inquiry card.

NEW LITERATURE

Copying Equipment. New 8-page bulletin X 260 presents maker's copying equipment that prepares masters of halftone and line subjects for offset, spirit and diazo duplicating.—The Haloid Co., Rochester 3, N. Y.

Circle **465** on inquiry card.

HUMIDITY, WATER

Humidity Recorders. New 6-page Bulletin H1008 describes maker's portable "Thermo-Humidigraph" that records temperature and relative humidity simultaneously on 24-hour or seven-day 8" or 12" chart.—The Bristol Co., Waterbury 20, Conn.

Circle **466** on inquiry card.

Humidity Control. New 4-page bulletin describes humidity regulator of the aspirating type that maintains relative humidity from 10% to 98%.—National Controls, Inc., Newton Centre 59, Mass.

Circle **467** on inquiry card.

Dehydration. New 4-page bulletin describes operation of maker's "Anhydryer" that removes water from air and other gases by double refrigeration and absorption.—Anhydry Co., Bishop, Calif.

Circle **468** on inquiry card.

Aftercooler. New 8-page Bulletin 130 describes maker's aftercooler for removing moisture and cooling compressed air or gases.—Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.

Circle **469** on inquiry card.

Air And Gas Compressors. New 8-page Bulletin 3132-A describes maker's air and gas compressors with electric, steam, gas or diesel power for pressures from deep vacuum to 35,000 psi and capacities up to 165,000 cu ft/min.—Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.

Circle **470** on inquiry card.

Low Temperature Drying. New 4-page reprint K-54-C describes use of maker's air conditioning equipment, utilizing chemical dehumidification for rapid drying at low temperatures during production of meteorological balloons.—Kathabar Div., Surface Combustion Corp., Toledo 1, Ohio.

Circle **471** on inquiry card.

Water Stills. New 48-page Catalog G describes operation of maker's water distillation units.—Barnstead Still & Sterilizer Co., 2 Lanesville Terrace, Forest Hills, Boston 31, Mass.

Circle **472** on inquiry card.

VIBRATION

Dynamic Balancing. New 4-page bulletin (I B-3004-Revised) presents maker's line of equipment for dynamic balancing of armatures, flywheels, etc.—Industrial Div., Bear Mfg. Co., Rock Island, Ill.

Circle **473** on inquiry card.

Vibration Analysis. New 2-page bulletin presents maker's new vibration analyzers to spot chatter, eccentricity, bearing failures and to locate cause of vibration.—International Research & Development Corp., 810 Thomas Lane, Columbus, Ohio.

Circle **474** on inquiry card.

OPTICS

Plane Optical Mirrors. New 4-page Bulletin FSM-4 describes maker's wide angle and image-forming instrument-quality precision first-surface mirrors, beamsplitters, and featherweight and general purpose mirrors. —Optron Laboratory, 2725 Salem Ave., Box 25, DV Station, Dayton 6, Ohio.

Circle **475** on inquiry card.

Optical Specialties. New catalog illustrates maker's line of optical specialties, including prismatic binoculars, telescopes, microscopes, magnifiers, barometers, compasses, etc.—Compass Instrument and Optical Co., Inc., 104 E. 25 St., New York 10, N. Y.

Circle **476** on inquiry card.

Borescope. New 1-page bulletin presents specs and accessories for maker's borescope for examination inside tubes, cylinders, etc.—Kollmorgen Optical Corp., 347 King St., Northampton, Mass.

Circle **477** on inquiry card.

Photocell. New bulletin presents maker's cadmium selenide photoconductive cell, said to be extremely sensitive in the red and near infrared region.—Clairex Corp., 50 W. 26 St., New York 10, N. Y.

Circle **478** on inquiry card.

Illuminators. New 4-page bulletin (Form 544-54) presents maker's line of illuminating equipment for the laboratory, including projectors, power suppplies, etc.—Burton Mfg. Co., 11201 W. Pico Blvd., Los Angeles 64, Calif.

Circle **479** on inquiry card.

MAGNETICS

Magnetic Remanence. New 8-page issue of "Applied Magnetics" (Vol. 4, No. 1) features an article on "Temperature Effects on Remanence of Alnico V, Alnico VI and Indox" describing tests separating and measuring reversible and non-reversible variations of remanence.—The Indiana Steel Products Co., Valparaiso, Ind.

Circle **480** on inquiry card.

Magnetic Separator. New 2-page bulletin describes maker's magnetic separator using concentrated magnetic field under low velocity liquid flow to separate ferrous particles and sludge from liquids.—Industrial Filtration Co., Lebanon, Indiana.

Circle **481** on inquiry card.

Magnetic Clutches and Brakes. New 8-page Catalog 955 presents specs and selection criteria for maker's line of magnetic clutches and brakes.—Dial Products Co., 9 Ave. E, Bayonne, N. J.

Circle **482** on inquiry card.

IS THIS THE INSTRUMENT YOU'RE LOOKING FOR?

Victoreen MODEL 640

LOW ENERGY RADIATION SURVEY METER

This new Model 640 Victoreen Radiation survey meter was developed to locate and measure the unknown health hazards emanating from the operation of industrial and medical high voltage equipment. With this instrument low energy and low intensity x-rays generated from magnetrons, hydrogen thyratrons, betatron magnets and other high voltage equipment can be measured at tolerance level intensities of as little as 6 mr/hr. It will also provide measurements in the presence of intense radio frequency fields. It can be used to check TV sets (both on the production line and in laboratory experiments) x-ray machines such as fluroscopes, shoe fitting machines and spectrometers. Other high voltage vacuum tube equipment such as diathermy machines, radio and TV transmitters and radar that generate health hazard rays can be definitely measured with the 640 survey meter.

THESE FEATURES ARE IMPORTANT

Two energy ranges are provided, 8-50 Kev with mylar window only and 50-2000 Kev with bottom cover plate in place. Can also be supplied with beryllium window if desired. Accuracy is ±10%. Readings in each range can be made within 2 seconds.

Three sensitivity ranges, 10; 100; 1000 mr/hr. are available and may be selected by external range switch. Instantaneous zero adjustment can be made by convenient external control. Coarse zero adjustment and meter calibration controls are inside instrument case to prevent erroneous adjustment.

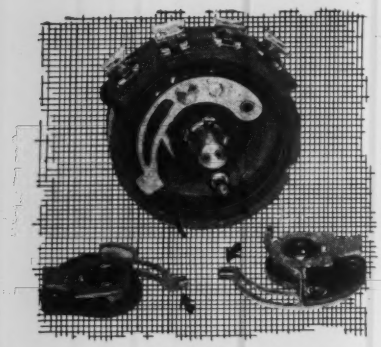
The 640 survey meter is compact and weighs less than 5 lbs. The attractive, aluminum case contains all components, including power supply consisting of a mercury cell and eight 22½ volt batteries which will provide well over 100 hours of operating life. A 100% negative feedback circuit eliminates the effects of differences in the tubes and components.

For detailed specifications write for Bulletin 3044.

The Victoreen Instrument Co.

5806 HOUGH AVENUE • CLEVELAND 3, OHIO

For more information circle **152** on inquiry card.



Arrows show Paliney #7 contacts used in this potentiometer manufactured by Clarostat Mfg. Co., Inc.

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TO TRANSMIT ELECTRICAL SIGNALS in precision instruments

Paliney #7*, a Ney precious metal alloy, has been selected by Clarostat Mfg. Co., Inc., Dover, N.H., for use as wipers and sliders in their precision potentiometers. The use of this alloy assures long service and shelf life, excellent maintained linearity and low noise within close tolerances throughout the life of the potentiometer.

Ney offers many other precious metal alloys which bring increased reliability to electrical or electronic precision instruments. Like Paliney #7, they have excellent electrical characteristics and resist tarnish. These alloys are widely used today in precision instruments throughout industry for sliding contacts, slip rings and assemblies, commutator segments and assemblies, brush and brush holder assemblies, and for precious metal resistance wire.

The Ney Engineering Department will be glad to study your particular contact problems and make suggestions and recommendations to improve the efficiency of your electrical or electronic instruments. Call or write Ney today.

(All contacts capsule-packed in plastic)

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Specialists in Precious Metal Metallurgy since 1812

*Registered Trade Mark

NEY'S small parts play a BIG part in precision instruments

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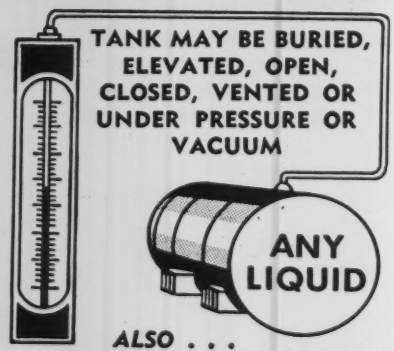
TANK-O-METER

FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY



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DEPTH & ABSOLUTE PRESSURE
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MERCURIAL BAROMETERS

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470 GETTY AVE., PATERSON, N. J.

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High Precision Optical Components Any Size For Astronomical and Physical Research

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Parabolic, Spherical, Ellipsoidal and Plane Mirrors

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Lenses & Prisms of Glass Natural or Synthetic Crystals

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Complete Optical and Mechanical Instruments

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Made to Specifications

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John Unertl Optical Co.

3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle **155** on inquiry card.

NEW LITERATURE

Pipe Detector. New 4-page bulletin describes maker's "Detectron" used for determining location and depth of pipes, cables and other metallic objects.—The Detectron Co., 5528 Vineland Ave., N. Hollywood, Calif.

Circle **483** on inquiry card.

TESTING, INSPECTION

Dynamic Engine Analyzer. New 4-page bulletin shows how maker's new "TV-Type Engine Analyzer" pinpoints source of trouble of auto engines under test.—Allen B. DuMont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.

Circle **484** on inquiry card.

High Potential Testing. New 7-page manual P-11915 "High Potential Dielectric Strength Testing With Hypot Juniors" provides instructions on dielectric testing techniques.—Associated Research, Inc., 3767 W. Belmont Ave., Chicago 18, Ill.

Circle **485** on inquiry card.

Image Intensifier. New 3-page bulletin provides application data on maker's new "Industrial Image Intensifier" for use in fluoroscopic X-ray examination of high-density metals.—Research & Control Instruments Div., North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y.

Circle **486** on inquiry card.

Surface Measurement. New 8-page Form LT 18 contains most of ASA Standard B46.1-1955 on surface roughness, waviness and lay, and lists instrument characteristics for roughness measurement.—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

Circle **487** on inquiry card.

Flexibility Tester. New 12-page issue of "Newsletter" (Vol. 3, No. 11) features an article on new impact-flexibility tester for determining the relative flexibility of a paint, varnish or enamel film.—Gardner Laboratory Inc., Bethesda 14, Md.

Circle **488** on inquiry card.

Wheel Bearing Grease Tester. New 2-page Bulletin 718 presents maker's wheel bearing grease tester for determining leakage tendencies of greases.—Precision Scientific Co., 3737 W Cortland St., Chicago 47, Ill.

Circle **489** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Electronic Instruments, Components. New 8-page brochure presents maker's accelerometers, cathode followers, filters, pressure and blast gages, ultrasonic generators, subminiature capacitors and resistors, etc.—Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Circle **490** on inquiry card.

Meter-relays. New 2-page bulletin MP-2 presents specs on maker's line of indicating meters with built-in relay contacts that operate on as little as 0.2 microampere or 0.05 millivolt. —Assembly Products, Inc., Wilson Mills Road, Chesterland, Ohio.

Circle **491** on inquiry card.

Oscilloscope. New 4-page bulletin features maker's "411 Easy-Six" wide-band test oscilloscope with vertical deflection bandwidth from dc to 10 Mc.—Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

Circle **492** on inquiry card.

Radio Interference Measurement. New 4-page bulletin features maker's radio interference and field intensity measuring equipment for 14 to 250 kc range.—Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.

Circle **493** on inquiry card.

Electronic Test Instruments. New 8-page price list issued February 15, 1956 by maker supersedes all previous lists.—General Radio Co., 275 Mass. Ave., Cambridge 39, Mass.

Circle **494** on inquiry card.

Expanded-Scale a-c Voltmeters. New 4-page Bulletin C-1 presents maker's line of expanded-scale a-c voltmeters that expands useful portion of the conventional scale and eliminates the rest.—Arga Div., Beckman Instruments, Inc., 220 Pasadena Ave., S. Pasadena, Calif.

Circle **495** on inquiry card.

Impact Noise Measurement. New 8-page issue of the "Experimenter" (Vol. 30, No. 9) features "The Measurement of Impact Noise" and new instrument developed to simplify these measurements.—General Radio Co., 275 Mass. Ave., Cambridge 39, Mass.

Circle **496** on inquiry card.

Pulse Transformers. New 4-page issue of "Valor Circuit Notes" (No. III) features article showing relationships which affect trigger-ability of plate triggered blocking oscillator circuits.—Valor Electronic Components Co., 5808 Marilyn Ave., Culver City, Calif.

Circle **497** on inquiry card.

Waveguide and Coaxial Calorimeters. New 4-page bulletin presents technical information and special features of maker's new liquid loads and calorimeter systems.—Chemalloy Electronics Corp., Gillespie Airport, Santee, Calif.

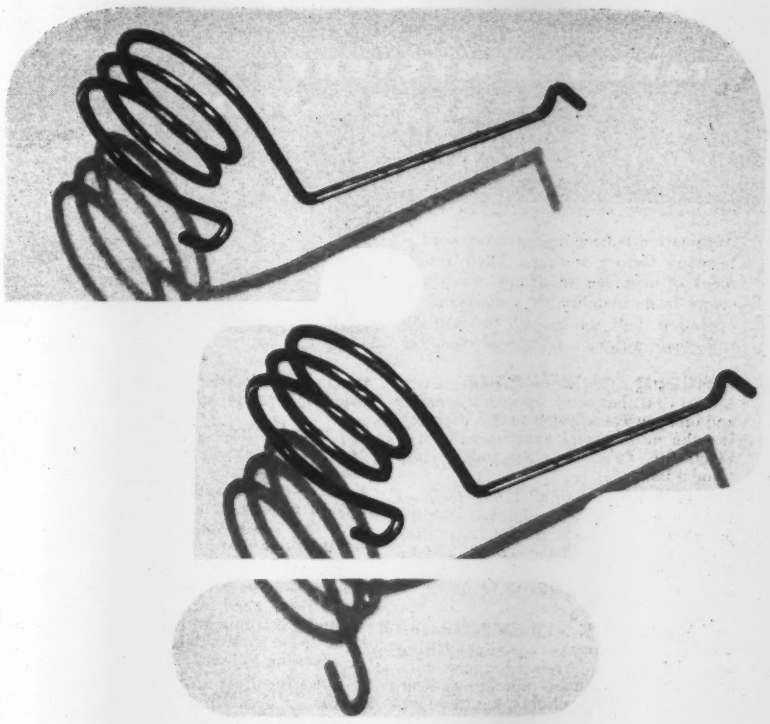
Circle **498** on inquiry card.

Voltage Calibrator. New 4-page brochure describes maker's a-c standard voltage calibrator with stated accuracy of 0.1% of indicated output.—Quare Associates, Canton, Mass.

Circle **499** on inquiry card.

CRT Tester. New 2-page bulletin presents maker's new "CRT Testivator", a self-contained picture tube test and repair instrument.—Century Electronics Co., 111 Roosevelt Ave., Mineola, N. Y.

Circle **500** on inquiry card.



Which Spring Costs More . . . and Why?

■ These springs look identical—and one will work as well as the other, yet one costs more. The higher cost spring was the product of time consuming engineering effort, plus a demand for unnecessary close tolerances and secondary production operations. The other was the simpler, low cost result of Lewis engineering experience and production know-how.

Lewis engineering experience is one of many "extras" you get when you make Lewis your source for springs. Whether it's help in spring design, packaging springs for efficient assembly line handling, or simply a case of getting top quality springs at competitive prices—call on Lewis.

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2648 W. North Avenue, Chicago 47, Illinois

Lewis PRECISION SPRINGS

The finest light springs and wireforms of every type and material

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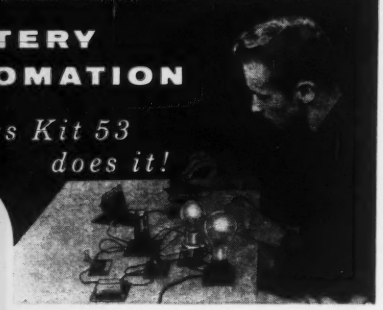
TAKE THE MYSTERY OUT OF AUTOMATION

new Crow Electronics Kit 53 does it!



Automation is becoming a scare word to many factory workers. Their resentment of complex electronic machinery stems from inability to understand its operation. Left unchecked, this attitude can create serious morale problems.

Understanding Promotes Acceptance—Crow Electri-Craft has come up with a sensible and inexpensive solution to this problem. It's the new "visual experiment" kit—Electronic, Tubes, Circuits and Devices (Model 53).

This "learn-by-doing" kit is designed to fit right into your employee training program . . . to explain the fascinating world of Electron Tube Theory, Radio Transmitting and Receiving, Radar, and Industrial Electronic Controls.

A Complete "Package"—Model 53 contains 108 quality components, everything needed to perform 65 related experiments. Students build their own operating assemblies—magnetic amplifiers, multi vibrators, photo electric controls, electronic counting circuits, and many more.

Easy to Understand—An illustrated 600-page manual shows how to build each assembly, discusses the theory involved and its practical application. No mathematical formulas . . . directions are so clear that the kits can even be used for self-instruction at home.

Model 53 is the latest in a series of low-cost kits developed by Crow to meet the growing need for widespread electrical and electronic knowledge. Crow Kits make these vital subjects easy to teach . . . exciting to learn.

Write for illustrated folder giving full details.

CROW ELECTRI-CRAFT CORP.
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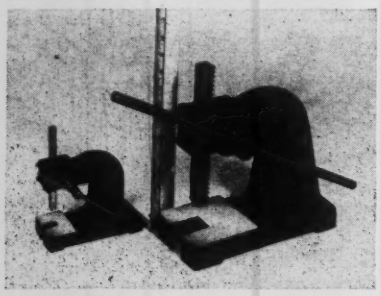

MICRO-PRESS

Designed for precision jobs requiring application of force. Extra heavy frame—Precision side and front gib plates—Ground work and mounting surfaces.

SPECIFICATIONS

	M-100	M-200
Arbor Size	3/8" sq.	3/4" sq.
Arbor Stroke	2 1/2"	4 1/2"
Throat Size	2 1/2"	4 1/2"
Working Force	2/3 Ton	1 Ton
Shipping Wt.	5 lbs.	25 lbs.

(Write for detailed information)

Micro Equipment Division of
DICKINSON & ASSOCIATES
557 East Walnut St., Pasadena 1, Calif.

For more information circle **158** on inquiry card.

New PRESET COUNTER by FREED

MODEL 2020

The Freed Model 2020 Preset Counter is designed for low cost reliable counting applications, where accuracy and maintenance-free operation is required.

Cold cathode counting and trigger tubes, with simplified circuits, are used throughout which assure years of trouble-free counting service and low-power consumption.

Model 2020 is a 4-digit single preset counter capable of controlling any operation that is repeated up to 9,999 times. Any number from 1 to 9,999 may be preset on the 4-digit selector switches. When the preset total has been reached, the counter will provide an output pulse and close contacts on a relay. These outputs may be used simultaneously or separately to stop machines, actuate control signals, or trigger additional equipment.

SPECIFICATIONS

Maximum Count: Four digits — 9,999	**Pulse output** 50 volts
Maximum counting rate: 300,000 counts per minute	**Size:** 8 x 6 x 12 inches
Input Sensitivity and Waveform: Not critical	**Weight:** 11 pounds
Outputs: Relay contact 10 Amperes	**Power:** 25 watts 105-125 volts, 50-60 cycles
	Price: $425.00

Freed also manufactures Transformers, Preset, and Batching Counters.
SEND FOR COMPLETE INFORMATION
Engineering assistance available for adapting these counters to your specific applications.

FREED TRANSFORMER CO., INC.
1707 Weirfield Street
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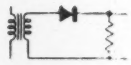
POWER SUPPLIES



Power Supplies and Regulators. New 4-page catalog presents condensed standard specifications on maker's power supplies, voltage regulators, voltage reference sources, frequency changers, etc.—Sorensen and Co., Inc., 375 Fairfield Ave., Stamford, Conn.

Circle **501** on inquiry card.

Radioactive Battery. New 4-page Bulletin F-1 provides specs on maker's radioactive battery, a high-potential, low-current source for up to 10kv at 50 micromicroamps.—Radiation Research Corp., 140 E. 59 St., New York 22, N. Y.

Circle **502** on inquiry card.

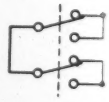
Germanium Rectifier. New 2-page Bulletin G125-400 describes maker's 50-kw germanium rectifier for heavy-duty industrial applications.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Circle **503** on inquiry card.

Airborne Conversion Equipment. New 4-page bulletin presents maker's line of aircraft power supplies.—Chatham Electronics Div., Gera Corp., Livingston, N. J.

Circle **504** on inquiry card.

RELAYS, SWITCHES



Instrument-Type Rotary Tap Switches. New 8-page Catalogue 17-SE presents maker's line of shorting and non-shorting type rotary tap switches made to order.—Cinema Engineering Co., 1100 Chestnut St., Burbank, Calif.

Circle **505** on inquiry card.

Relays. New 24-page Bulletin T5000 presents maker's line of relays with operating times from 0.008 sec. now available for industrial application.—Stromberg-Carlson Co., 100 Carlson Road, Rochester 3, N. Y.

Circle **506** on inquiry card.

Limit Switches. New 12-page Catalog 955 describes seven models and 19 contact arrangements of heavy duty limit switches.—R. B. Denison Mfg. Co., 102 St. Clair Ave., N.W., Cleveland 13, Ohio.

Circle **507** on inquiry card.

Altitude Switch. New 1-page bulletin describes maker's miniature altitude switch also available as an absolute or differential pressure switch.—Aero Mechanism, Inc., 3040 Overland Ave., Los Angeles 34, Calif.

Circle **508** on inquiry card.

Switches, Timers, Panels. New 4-page Catalog 4bGe presents specifications of maker's line of standard and special foot, lever, limit and push button switches; also synchronous-motor and electronic timers; also control panels.—General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.

Circle **509** on inquiry card.

RESISTORS, POTENTIOMETERS

Rheostats, Resistors. New 6-page pamphlet presents maker's line of rheostats, resistors, core winding machines and taping machines.—Rex Rheostat Co., Baldwin, L.I., N.Y.

Circle **510** on inquiry card.

Rheostat Potentiometer. New 4-page Bulletin A-3 describes maker's new 2-watt rheostat potentiometer.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle **511** on inquiry card.

Power Resistors. New 12-page Catalog Data Bulletin C-1a presents maker's line of tubular and flat, power wirewound resistors, including adjustable, non-inductive and stacking models.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle **512** on inquiry card.

Conductive Coatings. New 9-page Manual M 31 describes new approaches to use of electrically-conductive coatings.—Micro-Circuits Co., New Buffalo, Mich.

Circle **513** on inquiry card.

Electroplating Rheostats. New 4-page Bulletin CPR-200 describes maker's carbon-pile tank rheostats for electroplating, including rating chart, selection guide, etc.—Hanson-Van Winkle-Munning Co., Church St., Matawan, N. J.

Circle **514** on inquiry card.

Resistors, Potentiometers. New 4-page folder presents maker's line of resistors and potentiometers.—Schweber Electronics, 122 Herricks Road, Mineola, L.I., N.Y.

Circle **515** on inquiry card.

CONNECTORS

Electrical Connectors. New 12-page Bulletin B59 presents six groups of maker's round and oval integral-molded connectors.—Joy Mfg. Co., Oliver Bldg., Pgh. 22, Pa.

Circle **516** on inquiry card.

Electrical Fittings. New 4-page Bulletin 561 describes maker's line of pressure connectors, splice caps, insulators, lugs and conduit bushings.—Buchanan Electrical Products Corp., Hillside, N. J.

Circle **517** on inquiry card.

Miniature Connector. New 2-page Bulletin 16C presents maker's new "Series 20" miniature connector with coaxial contacts.—Electronic Sales Division, DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **518** on inquiry card.

FITTINGS

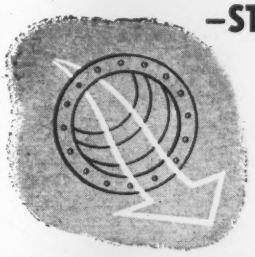
Self-Flaring Fittings. New 8-page brochure (1155-QP) presents specifications on maker's line of self-flaring fittings made of brass, monel, cadmium plated steel, stainless steel and anodized aluminum.—Century Controls Corp., Allen Blvd., Farmingdale, L.I., N.Y.

Circle **519** on inquiry card.

SMS ROTOVALVES

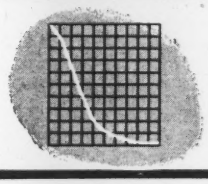
—STILL THE BEST VALVE YOU CAN BUY

Only Rotovalves give you all these features:

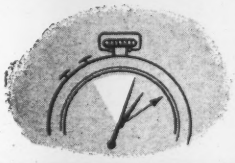


LEAST PRESSURE LOSS
Full line opening means less head loss, lower pumping costs.

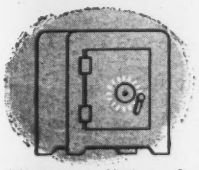
EASIEST TO OPERATE
Hydraulic imbalance and mechanical design mean 1 man can close as fast as required. Less power needed in mechanical or electrical operation.



GREATEST INITIAL SHUT-OFF
Rotovalve 55% closed at 25% stroke, and 92% closed at 50% stroke. In comparison, gate valves only 18% closed at 25% stroke and 43% closed at 50% stroke.



MOST CONTROLLED CLOSING TIME
Closing as quickly as one second or as slow as needed. Fast initial closing limits reversal of flow.



MOST POSITIVE CLOSING
Drop-tight, positive closing. Self-purging, monel-to-monel seating. Pressure-tight bolted head, stuffing box, and machined and lapped seats.

In addition to all these features typical of SMS engineering, Rotovalves have a flexibility that makes them suitable for any type of operation, any method of control, or any sort of location.

For detailed information about SMS Rotovalves, Ball or Butterfly Valves, see our local representative or write to the S. Morgan Smith Company, York, Pennsylvania.

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BEAM SPLITTERS
OPTICAL FILTERS

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Modern instruments require precision mirrors and optical parts to obtain maximum accuracy. Evaporated Metal Films, pioneer in applying optical coatings to glass surfaces, has the knowledge and experience necessary to produce the finest optical coatings available. Send for a free booklet describing various Evaporated coatings, beam splitters and optical filters.

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Ithaca, New York

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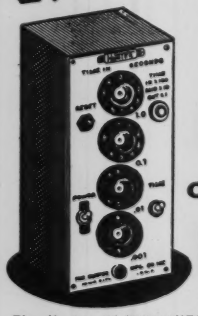
KLOCKOUNTER



IN ONE COMPACT UNIT

The Hunter KLOCKOUNTER does the job of a timing clock and a counter. The KLOCKOUNTER will count events at a rate of 2000 per second. Time intervals in units of one-tenth, one-hundredth, or one-thousandth of a second can be measured. The KLOCKOUNTER is completely silent in operation.

The Hunter KLOCKOUNTER is an instrument which will meet your most exacting requirements for quality, performance, reliability, and serviceability.

You save when purchasing a KLOCKOUNTER. You have a timer and a decade counter all in one compact unit, weighing less than eight pounds.

Write for more information today. And . . . receive FREE catalog of other Hunter equipment by return mail. It is important to you and you'll always be glad you did.

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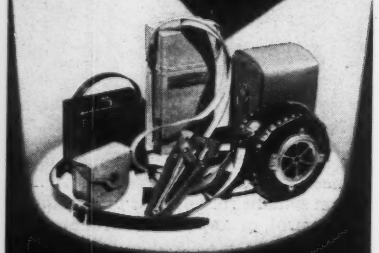

Protect your product.
Stimulate its sale.
Use Leather Cases by . . .

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Company
WORCESTER, MASSACHUSETTS

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ELECTRONIC COMPONENTS

Receiver Transistors. New 4-page Bulletin DL-S 568 presents specs and characteristics (including test circuit) for Types 2N145, 146 and 147 NPN grown-junction germanium transistors for 455-kc i-f use. New 2-page Bulletin DL-S 609 does same for Type 2N172 NPN grown-junction germanium transistor for converter use. Bulletin DLS-570 covers Type 310 PNP alloy-junction audio-driver transistor; and Bulletin DLS-610 covers Type 2N185 PNP alloy-junction audio output transistor.—Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9 Texas.

Circle **520** on inquiry card.

Transformers. New 82-page "Instrument Transformer Buyer's Guide' GEC-1028A provides data on all standard types of maker's transformers—potential, current, metering outfits, portable, thyrite protectors, tests etc.—General Electric Co., Schenectady 5, N. Y.

Circle **521** on inquiry card.

Current Transformer. New 8-page Bulletin GED-2727 presents information on application, construction, accuracy, mechanical and thermal ratings, and ratio and phase-angle test data on maker's new 15-kv outdoor current transformer.—General Electric Company, Schenectady 5, N. Y.

Circle **522** on inquiry card.

Components. New 80-page catalog presents illustrated schematics, specifications and descriptions of maker's line of plugs, jacks, leads, tools and associated components.—Insuline Corp. of America, 186 Granite St., Manchester, N. H.

Circle **523** on inquiry card.

Variable-Reluctance Cartridge. New 2-page bulletin presents maker's new variable-reluctance magnetic cartridge for both microgroove and standard-groove records.—Audiogersh Corp., 23 Park Place, New York 7, N. Y.

Circle **524** on inquiry card.

Electromagnetic Focus Coils. New catalog page presents maker's focus coils.—Syntronic Instruments Inc., 170 Industrial Road, Addison, Ill.

Circle **525** on inquiry card.

Continuous Phase-Shifting Capacitor. New 4-page bulletin presents specs and characteristics of maker's line of continuous phase-shifting capacitors to produce time delays or phase variations directly proportional to shaft rotation.—Nilsen Mfg. Co., Addison, Ill.

Circle **526** on inquiry card.

Capacitors. New 2-page Bulletin 178 describes maker's capacitors designed for split-phase capacitor-run motors.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Circle **527** on inquiry card.

Subminiature Capacitors. New 2-page Bulletin 528A presents specs on maker's line of subminiature, tantalum, polarized, electrolytic capacitors

for low-voltage applications.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

Circle **528** on inquiry card.

MECHANICAL COMPONENTS

Capsular Elements. New 8-page Bulletin AV2001 presents specifications, dimensions and diagrams of maker's line of Ni-Span C Capsular elements.—Aircraft Components Div., The Bristol Co., Waterbury 20, Conn.

Circle **529** on inquiry card.

Powdered-Metal Gears. New 4-page folder illustrates maker's custom fabrication of oval, bevel, spur, miter, internal and planetary gears of ferrous and non-ferrous bases.—Kwikset Powdered Metal Products, Anaheim, Calif.

Circle **530** on inquiry card.

Gear Boxes. New 2-page bulletin presents specs and torque characteristics of maker's gear boxes for use in actuators, computers, etc.—Southwestern Industries Inc., 5880 Centinela Ave., Los Angeles 45, Calif.

Circle **531** on inquiry card.

Constant-Torque Spring Motors. New 25-page Bulletin 310Mb presents general principles, physical and operational characteristics, applications and limitations of constant-torque spring motors using maker's "Neg'ator" spring.—Neg'ator Div., Hunter Spring Co., Lansdale, Pa.

Circle **532** on inquiry card.

O-Rings. New 4-page bulletin describes maker's line of metal O-rings, available in stainless, monel, inconel and inconel X.—The Advanced Products Co., P. O. Box 75, N. Haven, Conn.

Circle **533** on inquiry card.

Shafts, Rolls, Guide Rods. New 6-page Form 301 presents maker's hardened and ground shafts, rolls, rods and other long-round parts.—Thomson Industries, Inc., Manhasset, N. Y.

Circle **534** on inquiry card.

Nylon Balls. New Bulletin NY 41-55 presents maker's nylon balls from $\frac{1}{8}$" to $\frac{3}{4}$" dia.—Industrial Tectonics, Inc., Ann Arbor, Mich.

Circle **535** on inquiry card.

Automatic Lubricator. New 2-page Bulletin 55B presents maker's ratchet-driven lubricator designed for servicing small machines where an oscillating drive is available.—Bijur Lubricating Corp., Rochelle Park, N. J.

Circle **536** on inquiry card.

Rubber Components. New 8-page brochure describes maker's facilities for producing custom-made rubber parts and components.—Goshen Rubber Co., Inc., Goshen, Indiana.

Circle **537** on inquiry card.

Brass Pressure Die Castings. New 4-page bulletin describes maker's facilities for brass pressure die castings.—Titan Metal Mfg. Co., Bellefonte, Pa.

Circle **538** on inquiry card.

Aircraft Pulleys. New 4-page bulletin (Form 622) presents specifications on maker's line of "No-Glo", ball-bearing plastic pulleys that won't

SIE

MODEL E-2

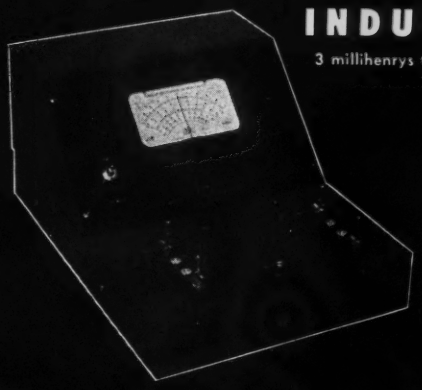
COMPARISON BRIDGE

for fast, accurate matching and measuring of

RESISTORS 1 ohm to 5 megohms

CAPACITORS 500 mmfd to 2000 mfd

INDUCTORS 3 millihenrys to 10,000 henrys



Sloping meter face and wide-spaced component clips speed production line testing. Foot operated switch* allows two-hand operation.

Stable, high-gain, circuit permits the detection of component differences amounting to only 1 part in 10,000. Five meter ranges indicate differences at 1%, 2.5%, 10% and 25% value full scale.

In the design laboratory, or in assembly operations, the E-2 Comparison Bridge offers accuracy, flexibility, and dependability.

★ EASY TO USE — Spring clip, and banana-plug terminals.

★ HAND OR FOOT OPERATED — *Foot control optional at extra cost.

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205 55 REPRESENTATIVES THROUGHOUT THE WORLD

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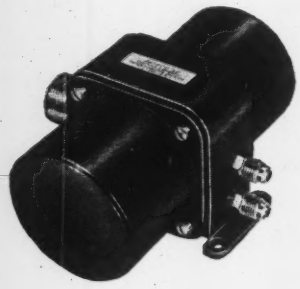
PRESSURE TRANSDUCERS

featuring Fairchild accuracy and reliability

The unit shown features two pressure-sensitive diaphragm elements which actuate two precision potentiometers through a dynamically-balanced, stable mechanical linkage. Variations of size, conformation and pressure ranges for measurement of differential, absolute or gauge pressures are also available. For complete information, write Fairchild Controls Corp., Components Division, 225 Park Avenue, Hicksville, L. I., N. Y.; **West Coast:** 6111 E. Washington Blvd., Los Angeles, Calif., Dept. 140-70b1.

The TPD-300 Transducer introduces a new line of Fairchild controls, featuring all the characteristics of precision, reliability and quality that are identified with Fairchild potentiometers. Now, pressure transducers will be available to you in a wider range of resistances in either linear or functional, single or dual potentiometer output elements.



FAIRCHILD
PRECISION POTENTIOMETERS
PRESSURE TRANSDUCERS

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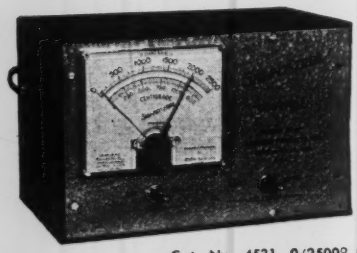
SIMPLYTROL AUTOMATIC PYROMETER



Cat. No. 4531 0/2500° F.
Price $132.00

Thermocouple type Automatic Pyrometer for controlling temperature in furnaces, ovens, and processes. The Simplytrol is economical and reliable with few moving parts. There are no vacuum tubes. The regular load relay is S.P.D.T. 5 Amps. Optional heavy duty relays to 40 Amps.

10 temperature ranges cover from −75° to 3000° F. Several special ranges to −400° F. "On & Off" control for holding the desired temperature works on gas, oil or electric heat. Indicating meter-relay is medium high resistance and has bimetal cold junction compensation. For use with all standard thermocouples. Accuracy 2%.

"Auto-Limit" switch changes Simplytrol from automatic controller to limit pyrometer for safety shut down or warning. Cabinet: 6½x6½x9½ inches. Also flush panel mount models. Send for new Bulletin G-7 for more data. Assembly Products, Inc., Chesterland 10, Ohio.

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Newly Revised ELECTRONIC TEST EQUIP. DATA SHEETS

ENGINEERS

These DATA SHEETS will save your firm thousands of dollars in searching for data on ELECTRONICS TEST EQUIPMENT and give you comprehensive and descriptive data easily accessible for comparison. They are current and packed with vital working information Now available to industry for the first time.

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CARL L. FREDERICK AND ASSOCIATES
Bethesda 14, Maryland

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NEW LITERATURE

burn when flame is removed.—The Formica Co., 4628 Spring Grove Ave., Cincinnati 32, Ohio.
Circle **539** on inquiry card.

Welded Tubing. New 4-page Bulletin TB-362 describes solutions of production problems by use of maker's electric-resistance-welded, carbon-steel, mechanical tubing.—Tubular Products Div., The Babcock & Wilcox Co., Beaver Falls, Pa.
Circle **540** on inquiry card.

MATERIALS

Cemented Carbides. New 66-page Catalog GT-310 presents graphs for selection of most effective cutting speeds, machine tool horsepower requirements, shank size of single-point tools, carbide grades and carbide tool geometries. Included are 12 pages of specs.—Carboloy Dept., General Electric Co., Detroit 32, Mich.
Circle **541** on inquiry card.

Beryllium Copper. New 4-page Bulletin 32 illustrates use of beryllium copper castings.—The Beryllium Corp., Reading, Pa.
Circle **542** on inquiry card.

Copper-Clad Laminates. New 2-page Bulletin AR-2a provides data on maker's new copper-clad, fluorocarbon plastic for printed circuitry.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.
Circle **543** on inquiry card.

Synthetic Rubber. New 8-page Bulletin A-509 describes properties of "Hypalon", maker's new synthetic rubber claimed to have outstanding heat, weather, ozone and chemical resistance.—Elastomers Div., E. I. du-Pont de Nemours & Co., Wilmington 98, Del.
Circle **544** on inquiry card.

Colloidal Dispersions. New 4-page Bulletin 425 presents line of colloidal dispersions used to lubricate the surfaces of die cavities in permanent molds.—Acheson Colloids Co., Port Huron, Mich.
Circle **545** on inquiry card.

Surface Alloying. New 4-page reprint "Effective Use of Chromizing in Modern Production" describes impregnation of chrome in ferrous surfaces for resistance to heat, corrosion, wear and abrasion.—Chromalloy Corp., 450 Tarrytown Road, White Plains, N. Y.
Circle **546** on inquiry card.

Reinforced Plastic Insulation. New 12-page brochure contains characteristics chart, comparison charts, and information on "Haysite" glass-reinforced, polyester insulating material.—Reinforced Plastics Div., Hays Mfg. Co., W. 12 St., Erie, Pa.
Circle **547** on inquiry card.

Elastomer. New 16-page and 12-page companion brochures describe "Kel-F" elastomer. 16-page applications book is designed for those who use or specify. 12-page book describes methods of compounding, vulcanizing and fabricating.—The M. W. Kellogg Co., P. O. Box 469, Jersey City 3, N. J.
Circle **548** on inquiry card.

Plastic Parts. New 32-page catalog illustrates molded phenolic plastic parts available without tooling cost, including handles, knobs and cases.—Harry Davies Molding Co., 1428 N. Wells St., Chicago 10, Ill.

Circle **549** on inquiry card.

Plastics. New 52-page catalog lists thermoplastic and phenolic sheets, rods, tubes, films and includes table of properties.—Cadillac Plastic and Chemical Co., 15111 Second Ave., Detroit 3, Mich.

Circle **550** on inquiry card.

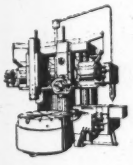
Forming Material. New 4-page bulletin (Form 604) features use of maker's formica resin impregnated, paper base forming material.—The Formica Co., 4614 Spring Grove Ave., Cincinnati 32, Ohio.

Circle **551** on inquiry card.

Powder Metallurgy Bibliography. New 4-page powder metallurgy bibliography refers to 250 articles and papers printed in journals and magazines during 1954 and 1955.—Harper Electric Furnace Corp., 39 River St., Buffalo 2, N. Y.

Circle **552** on inquiry card.

MACHINERY, FABRICATION



Sheet-Metal Hand Tools. New 12-page Bulletin 78-B introduces nine new hand tools and tools for the sheet-metal worker.—Niagara Machine & Tool Works, 683 Northland Ave., Buffalo 11, N. Y.

Circle **553** on inquiry card.

Hand Tools. New 480-page Catalog 27 illustrates maker's line of tools, including micrometer calipers, dial gages, hole gages, vernier calipers and gages, rules, squares, etc.—The L. S. Starrett Co., Athol, Mass.

Circle **554** on inquiry card.

Drill Heads. New 4-page brochure describes maker's drill heads that drill up to 12 holes in one stroke.—Johnson Drill Head Co., 23 Ave., and 20 St., Rockford, Ill.

Circle **555** on inquiry card.

Metallic Cleaners. New 4-page Bulletin C-108 presents maker's cleaners and use in soak cleaning, electrocleaning, barrel cleaning, etc.—Hanson-Van Winkle-Munning Co., Church St., Matawan, N. J.

Circle **556** on inquiry card.

Pig-Tailoring. New 14-page booklet presents maker's "Pig-Tailor" and "Spin-Pin" that simplify component preparation and assembly.—Bruno-New York Industries Corp., 460 W. 34 St., New York 1, N. Y.

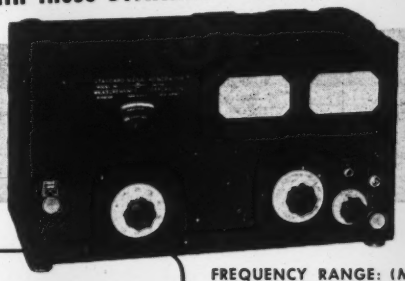
Circle **557** on inquiry card.

(*Continued on page* 810)

EXTENDED FREQUENCY RANGE

with these STANDARD SIGNAL GENERATORS

MODEL 80
2 Mc to 400 Mc
MODEL 80-R
5 Mc to 475 Mc



FEATURES

- Direct-Reading scales and dials; individually calibrated.
- Convenient microvolt and DBM output scales.
- Accurate indication of output voltages at all levels.
- Low residual FM due to hum and noise.
- Provision for external pulse modulation.

SPECIFICATIONS

FREQUENCY RANGE: (Model 80) 2 to 400 Mc in 6 bands. (Model 80-R) 5 to 475 Mc in 6 bands.
FREQUENCY ACCURACY: ± 0.5%
FREQUENCY DRIFT: Less than .1% after warm-up.
OUTPUT VOLTAGE: Continuously variable from 0.1 to 100,000 microvolts (−7 to −127 DBM).
OUTPUT ACCURACY: ±10% at 0.1 volt from 5 to 200 Mc. ±15% at 0.1 volt from 200 to 475 Mc.
MODULATION: AM is continuously variable from 0 to 30%. Internal modulation, 400 and 1000 cycles. External modulation, 50 to 10,000 cycles.
RESIDUAL FM: Less than 500 cps at 450 Mc for Model 80-R, and correspondingly lower for both models at lower frequencies.
POWER SUPPLY: 117v, 50-60 cycles, 70 watts.

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CIRCLES & SPECIAL SHAPES

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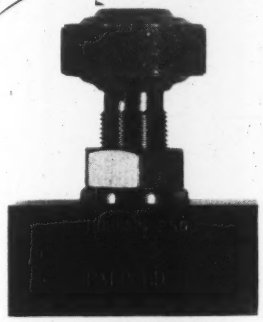

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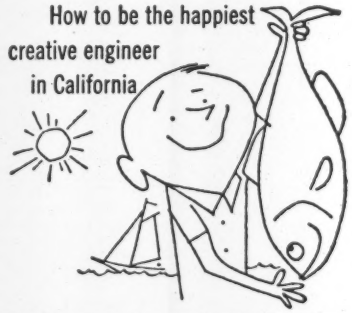

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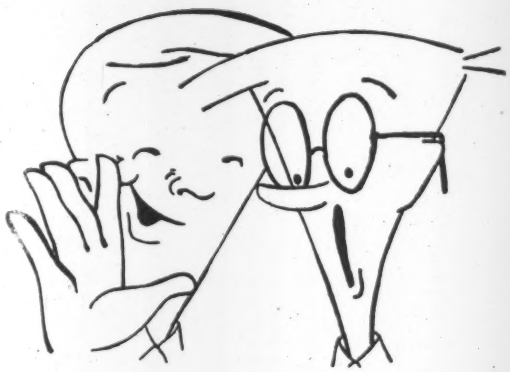

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NEW LITERATURE

Continued from page 803

Metalworking Machinery. New 12-page booklet "4 in 1" describes maker's four lines of mass-production, metalworking machinery.—Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Circle **558** on inquiry card.

Seam Welder. New 6-page Bulletin 316-7 describes maker's air-operated, press-type, low-impedance, single-phase seam welder.—Sciaky Bros., Inc., 4915 W. 67th St., Chicago, Ill.

Circle **559** on inquiry card.

Silver Brazing Fluxes. New 16-page Manual (Form 50), "A Complete Guide to Selective Fluxing for Low Temperature Silver Brazing," introduces two new fluxes to maker's line, describes proper fluxing practice, and includes a flux selector chart.—The American Platinum Works, 231 New Jersey Railroad Ave., Newark 5, N. J.

Circle **560** on inquiry card.

Welding Stainless Croloy. New 4-page Brochure TDC 162A describes welding characteristics and recommended arc welding procedures for maker's stainless tubing and pipe.—Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

Circle **561** on inquiry card.

Copy-Grinding Machine. New 4-page bulletin describes imported machine that grinds duplicate lathe tools, form tools, thin profile gages and parts simultaneously.—Carl Hirschmann Co. Inc., 30 Park Ave., Manhasset, N. Y.

Circle **562** on inquiry card.

Extrusions. New 16-page brochure describes technique to extrude alloy and stainless steels in small lots.—Metals Div., The H. M. Harper Co., 8200 Lehigh Ave., Morton Grove, Ill.

Circle **563** on inquiry card.

MISCELLANEOUS

Subminiature Gyro Compass. New 24-page brochure describes operation and application of maker's two-degree-of-freedom, fluid-suspended, subminiature gyro compass.—Arma Division, American Bosch Arma Corp., Garden City, Long Island, N. Y.

Circle **564** on inquiry card.

"Accidental Scientific Discoveries." New 64-page booklet reviews 21 discoveries ascribed to "accident" and emphasizes the preparedness of each scientist to make use of the chance occurence to further his work.—Schaar and Co., 754 W. Lexington St., Chicago 7, Ill.

Circle **565** on inquiry card.

Ultrasonic Cleaning. New 2-page bulletin C-2 presents maker's "Sonicells" for ultrasonic processing including cleaning, pickling, plating, bleaching, emulsification, dispersion, etc.—The General Ultrasonics Co., 1240 Main St., Hartford 3, Conn.

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Interval Timers. New 4-page Bulletin 203 describes maker's line of synchronous-motor-driven, operation interval timers for single and multiple sequence control.—National Time & Signal Corp., 21800 Wyoming Ave., Detroit 37, Mich.

Circle **567** on inquiry card.

Chopper Components. New 5-page bulletin provides data on maker's new dpdt chopper components.—James Vibrapowr Co., 4036 N. Rockwell St., Chicago 18, Ill.

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Miniaturization. New 12-page brochure presents maker's facilities for sub-contract work to miniaturize instruments, equipment, etc.—Practical Miniaturization, Ordnance Div., Elgin National Watch Co., Elgin, Ill.

Circle **569** on inquiry card.

Plant Layout. New 4-page folder describes kit useful in rapid preparation of various layout alternatives for plant or office, construction or remodelling.—Gross Eng. Co., White Pigeon, Mich.

Circle **570** on inquiry card.

Induction Soldering. New 4-page Bulletin 561 features laboratory model radio-frequency induction power generator as latest addition to maker's line of induction heating equipment.—McDowell Electronics, Inc. P.O. Box 342, Metuchen, New Jersey

Circle **571** on inquiry card.

Sand Blast Gun. New descriptive sheet presents maker's portable sand blast gun that contains abrasive in one quart can and connects to any air line.—Lindberg Products Co., P. O. Box 885, Los Gatos, Calif.

Circle **572** on inquiry card.

Heat Exchanger. New 2-page Catalog Sheet 80201-1 describes performance of maker's liquid-to-air or air-to-liquid heat exchanger for use in closed-system liquid circuits.—Rotron Mfg. Co., Inc., Schoonmaker Lane, Woodstock, N. Y.

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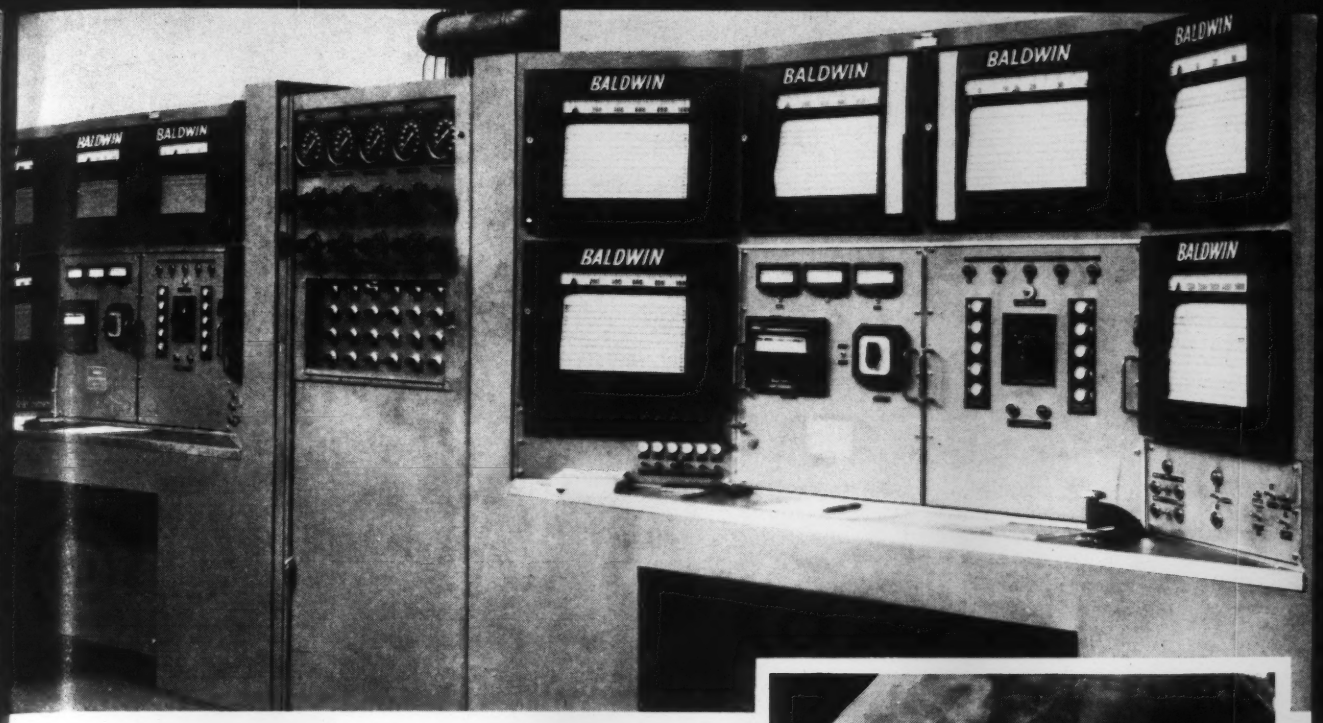

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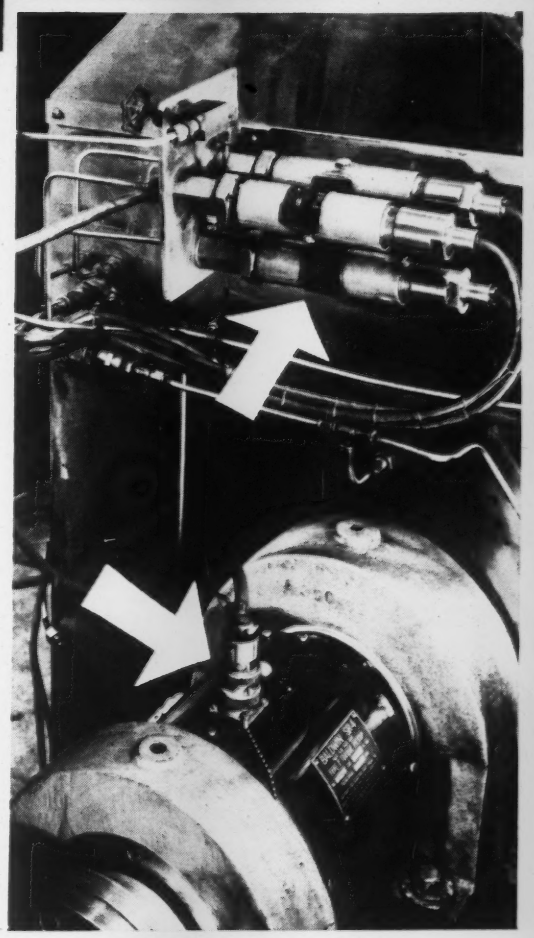

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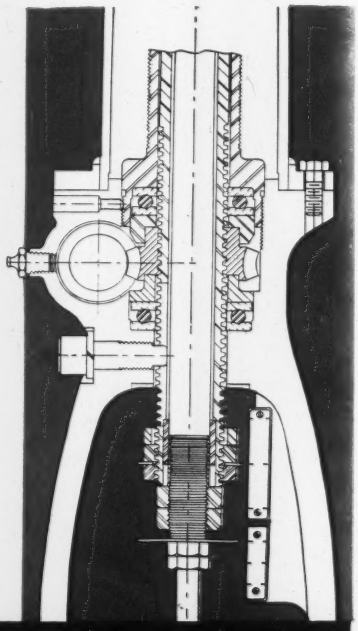

COMPLETE Information in (H-D) Bulletin 109-A

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